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The Seventh EEEIC International Workshop on Environment and Electrical Engineering

EEEIC 2008

Welcome from the Conference Chair

In the time of increased awareness about the environment problems by the public opinion and also intensive international efforts to reduce emissions of green house gases, as well increase of the generation of electrical energy to facilitate industrial growth, the conference offers broad contribution towards achieving the goals of diversification and sustainable development.

The scope of the conference is to promote the views of scientists and students from Lower Silesia (Wroclaw University of Technology) and Brandenburg (BTU Cottbus) and as well as industrial and cultural highlights present in the region. The conference offers prominent academics and industrial practitioners from all over the world the forum for discussion about the future of electrical energy and environmental issues and presents a base for identifying directions for continuation of research.

The renewed interest in electrical engineering an energy topics in general contributes to the revival of the industry and encourages us to announce the next EEEIC 2009 Conference, which will be held in May 2009 in a marvelous spa resort Karpacz in south-western Poland.

Professor Harald Schwarz
BTU Cottbus (Germany)

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ENERGA

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ENERGOBALTIC

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ENERGOBALTIC

ENERGOBALTIC was established in 1997 by PTS HYDROMEX Sp. z o.o. and Przedsiębiorstwo Poszukiwań i Eksploatacji Złóż Ropy i Gazu (Exploration and Exploitation of Oil and Gas Deposits Company) PETROBALTIC SA. In December 2000 Rolls-Royce Power Ventures (Władysławowo) Ltd from Great Britain joined the company as a shareholder. The initial capital of the company amounts to PLN 14.701.500. The largest number of shares in the Company are held by PETROBALTIC SA with 46,6%, the British company holds 41,4% and PTS Hydromex Sp. z o.o. 12%.

The prime undertaking of our company is the utilisation of waste gas from Petrobaltic offshore platforms. This task was realised based on an innovative idea, for which the principal author was Lech Kownacki who was appointed as the Chairman of the Management Board.

This undertaking was achieved by constructing a combined heat and power (CHP) plant in Władysławowo burning fuel gas. This is an environmentally friendly project because over 120 local coal-fired boilers and boiler houses, which were the source of so-called "low emissions", were liquidated. Therefore the operating plant protects the atmosphere against the emission of over 130 thousand tons of pollutants per year.

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ENVIRONMENTAL EFFECT

The ENERGOBALTIC project allows the elimination of the traditional sources of heat (coal-fired or heating oil boiler houses) and their replacement with a new centralised and ecologically clean source of heat, fed with waste gas from the offshore oil wells.This investment has made it possible to shut down about 120 coal/oil-fired boilers and boiler houses of a total power of 18 MWt and to supply ca. 76 000 MWh of electricity to the national power network per year. Among the liquidated boiler houses ca. 90% are coal-fired boiler houses. Others are oil boiler houses whose operation costs are much too high for their owners. It was necessary to build a district heating system in order to connect recipients. This system was built with the help of pre-lagged technology in conformity with the latest technology in this field.The significant ecological effect is obtained also due to production of electricity and propane-butane.

The planned operation of heat and power generating plant shall enable utilisation of 100.000 m3 of gas per day which was unproductively flared, and therefore shall eliminate use of ca. 75.000 tons of coal per year! (ca. 2 thousand train cars)

Production of electricity - elimination of use of 36.000 tons of coal per year
Production of heat - elimination of use of 7.000 tons of coal per year
Production of propane-butane - elimination of use of 32.000 tons of coal per year

Apart from a significant improvement to the cleanness of the air, the planned ecological effect consists in limiting the use of coal, eliminating the inconvenience connected with rail and road transport of coal, also its handling and storage and at the same time reducing the amount of solid waste produced whilst burning the coal.

The proposed solution meets the latest trends in world power engineering and has the lowest ecological costs amongst the accessible power engineering solutions. It is also in accordance with the Polish power engineering law, which takes into account the recommendations of the European Economic Commission, the Second Sulphur Protocol and the Framework Convention of the United Nations (concerning the changes of climate).

Target ecological effects of the Project:

TYPE OF POLLUTION (EMISSION)	Emission		Reduction (ton/year)
	Coal (ton/year) up to the present	Gas (ton/year) target	
Dust generally	133	0	133
Sulphur dioxide	648	0	648
Nitrogen dioxide	1 912	33	1 879
Carbon monoxide	5 701	16	5 685
Carbon dioxide	175 716	49 300	126 416
Benzo-alfa-piren	0,083	0	0,083
Soot	5,1	0	5,1
Total	184 110	49 349	134 761

The completion of the construction of the Władysławowo Combined Heat and Power Generating Plant finally results in:
- Reducing discharged pollutants from local boilers and CHP plant down to 134,761 tons/year;
- A decrease of solid waste as a result of replacing solid fuel (coal) with gas.

Firma ENERGOBALTIC sp z o.o. została założona we wrześniu 1997 roku przez Przedsiębiorstwo Technik Specjalnych HYDROMEX Sp z o.o. oraz Przedsiębiorstwo Poszukiwań i Eksploatacji Złóż Ropy i Gazu Petrobaltic SA.. W grudniu 2000 roku
do spółki jako udziałowiec przystąpiła firma ROLLS-ROYCE POWER VENTURES Ltd z Wielkiej Brytani.
Podstawowym zadaniem naszej Spółki jest zagospodarowanie gazu odpadowego z morskich platform wydobywających ropę naftową z dna Morza Bałtyckiego.
Przedsięwzięcie ma charakter proekologiczny, gdyż w ramach jego realizacji zlikwidowanych zostało już 120 lokalnych kotłowni węglowych i olejowych, będących źródłem tzw „niskiej emisji”
Elektrociepłownia we Władysławowie jest unikalnym zakładem w skali Polski, a nawet Europy.
Paliwem zasilającym elektrociepłownie jest gaz dostarczany na ląd nowo wybudowanym rurociągiem podmorskim o długości 82,5 km i średnicy rurociągu zaledwie 115 mm.
Obecnie gaz „morski” po dostarczeniu do elektrociepłowni we Władysławowie podlega separacji i w dalszej produkcji otrzymujemy cztery produkty : energie elektryczna, energie cieplną, gaz propan butan (LPG) oraz kondensaty gazu (KGN).
Po oddzieleniu LPG i KGN, leki gaz (mieszanina metanu i etanu) przesyłana jest dla zasilana dwóch turbin gazowych typu AlLison KB7s amerykańskiej firmy RollsRoyce Corporation z wykorzystaniem spalin w kotłach odzysknicowych o mocy nominalnej 8,5 MWt i trzech kotłów wodnych. o mocy nominalnej 5MWt. Skroplony propan – butan i KGN są magazynowane i sprzedawane firmom zewnętrznym.

EEEIC 2008

Regular Papers

Students papers

Methods of Determining Internal Parameters of Varistor Model

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***Abstract-* ZnO varistors are semiconductor devices with highly nonlinear current-voltage characteristic and are widely used as devices for overvoltage protection. Varistor applications range from the use of small varistors to protect electronic components to large varistors for protection of power systems. This paper presents proposed model of ZnO varistor and methodology of its mathematical analysis and simulation. The mathematical analy-sis of the proposed model makes it possible simulate the current trace on a nonlinear element.**

I. Introduction

Varistors are ceramic elements whose current-voltage (I-V) characteristic is highly nonlinear [1]. The varistors are usually manufactured in the ceramic process, in which pressed zinc oxide with admixtures of other metallic oxides is sintered. A matrix made up of ZnO grains enclosed by an intergranular layer composed of dissolved oxide admixtures forms the obtained microstructure [2-5].

Numerous, more or less complicated ZnO varistor models can be found in the literature [6-10]. The above model is a starting point for our considerations, but under the assumption that the influence of the capacitance nonlinearity is negligible and that the additional impedance due to the finite conduc-tance and capacitance of the intergranular phase has a signifi-cant effect on the model response.

Thus the simple ZnO varistor model proposed here can be presented as:

- the nonlinear resistance of intergranular boundaries and the linear capacitance associated with the impoverished re-gion, and
- the capacitance-resistance impedance associated with the intergranular phase. Your goal is to simulate the usual appearance of papers in an *IEEE conference proceedings*. For items not addressed in these instructions, please refer to the last issue of your conference's proceedings or your Publications chair.

II. Mathematical Analysis Of The Model

The analysed ZnO varistor model is shown in Fig. 1. The superposition method, the first harmonic method or the con-volution method can used to describe mathematically the equivalent circuit diagram, assuming that the supply voltage is sinusoidal.

The superposition method was used to describe the varistor model in [11].

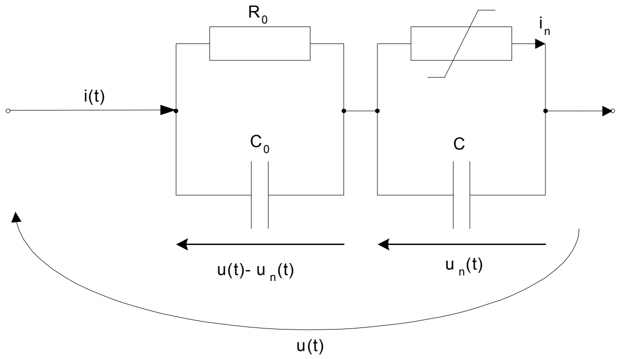

Figure 1. Analytical model for the ZnO varistor

If the model's parameters are known, it can be described using the first harmonic method.

A. First harmonic method

The relationship between the rms values of u(t) and (t) is as follows:

$$U = F(I) \tag{1}$$

The rms values are assumed to be first harmonic rms values:

$\underline{U}_{(\omega)} = Ue^{j\varphi}$; $\underline{I}_{(\omega)} = I$ and $\underline{U}_{(k\omega)} = 0$; $\underline{I}_{(k\omega)} = 0$ for k>1

Hence

$$\underline{U}_{N(\omega)} = Ue^{j\varphi} - \underline{Z}_{A(\omega)} I \tag{2}$$

$$\underline{I}_{N(\omega)} = [1 + \underline{Y}_{B(\omega)} \underline{Z}_{A(\omega)}] I - \underline{Y}_{B(\omega)} Ue^{j\varphi} \tag{3}$$

Such a phase shift φ should be selected that $\underline{U}_{N(\omega)}$ and $\underline{I}_{N(\omega)}$ are in phase (as on a nonlinear resistance element).

Thus φ must satisfy this equation:

$$\mathrm{Re}[\underline{U}_{N(\omega)}]\,\mathrm{Im}[\underline{I}_{N(\omega)}] = \mathrm{Im}[\underline{U}_{N(\omega)}]\,\mathrm{Re}[\underline{I}_{N(\omega)}] \tag{4}$$

Equation (1) is calculated for an assumed value of I and from the equations:

$U_N = \left|\underline{U}_{N(\omega)}\right|$, $I_N = \left|\underline{I}_{N(\omega)}\right|$ for a determined value of φ.

In this way the relationship which describes nonlinear element $U_N = f_I(I_N)$ is determined parametrically since U_N and I_N are parameterised by variable *I*.

It should be noted that the nonlinear element is treated as quasilinear, i.e. linear for transients and nonlinear for rms values, and that in the above methods the varistor's internal parameters are assumed to be known and their values affect the form of the solution.

B. Calculation of internal parameters

The varistor model consisting of linear elements with unknown parameters R_0, C_0, C and a resistance element with unknown characteristic $u_n = f(i_n)$.

The circuit's current response is described by this equation:

$$i(t) = \frac{1}{R_0}[u(t) - u_n(t)] + C_0 \frac{d}{dt}[u(t) - u_n(t)] \qquad (5)$$

where:

$u(t) = U_m \sin \omega t$ - the circuit supply voltage;

$u_n(t) = U_{1n} \sin(\omega t + \Psi_1) + U_{3n} \sin(3\omega t + \Psi_3)$ - the voltage on the nonlinear element, consisting (for simplicity) of the first harmonic and the second harmonic;

R_0 – an unknown resistance of the model's linear element;

C_0 – unknown capacitances of the model's linear element;

$U_{1n}, U_{3n}, \Psi_1, \Psi_3$ - respectively unknown amplitudes and initial phases for the first harmonic and the second harmonic of the model nonlinear element voltage.

For the selected 6 times (as many as there are unknowns) and the corresponding known values of voltage samples and the varistor model supply voltage the following system of equations:

$$i(t_l) = \frac{1}{R_0}[u(t_l) - u_n(t_l)] + C_0 \{\frac{d}{dt}[u(t) - u_n(t)]\}_{t=t_l} \qquad (6)$$

where:

t_l – for l=1,2,...,6 is solved.

Having calculated R_0, C_0 and the nonlinear element voltage, one can determine capacitance C. For this purpose we formulate the following equation for the varistor nonlinear element voltage:

$$f(u_n) = i(t) - C\left(\frac{du_n}{dt}\right) \qquad (7)$$

For suitably selected t_0 at which: $u_n(t_0) = 0$ equation (7) assumes this form:

$$f(u_n(t_0)) = i(t_0) - C\left(\frac{du_n}{dt}\right)_{t_0} = 0\,, \qquad (8)$$

whereby it becomes possible to calculate linear capacitance C of varistor model.

III. CONCLUSIONS

Two more mathematical descriptions of the varistor model have been presented. They can be applied to solve problems connected with the operation of varistors as nonlinear elements in electric circuits. The presented *first harmonic method* can be treated as an alternative to the superposition method described in [11] if the model parameters are known. If not, one can determine them in the way described in this paper's section IIB.

Currently intensive research on the application of the above problems to the analysis of actual varistor operation is being conducted.

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Artificial Neural Network for Real-Time Estimation of Basic Parameter of Signals

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***Abstract-* This paper presents for students instructions to using parallel algorithms, which can be implemented by analogue adaptive circuits employing some neural networks principles for estimation of parameters of signals in power system. Algorithms based on the standard least-squares (LS) criteria is proposed. The problem of estimation is formulated as an optimization problem and solved by using the gradient descent optimization algorithm. The corresponding architectures of analogue neuron-like adaptive processors are also shown.**

I. Introduction

For the control and protection of electrical power systems it is desired to estimate in real-time the parameters of the basic waveform (fundamental harmonic) of voltages and currents.

For this purpose various numerical algorithms have been proposed, e.g. based on the Fourier and Kalman filtering [1-4]. Most of the algorithms are not fully parallel algorithms, so that the speed of processing is quite limited.

Recently, much attention has been paid to the methods of artificial neural networks because of their potential new algorithms and architectures for parallel computing systems [3-5].

In the paper are algorithms and along with them new architectures of analogue neuron-like adaptive processors for online estimation of parameters of sinusoidal signals, which are distorted by exponential DC components and corrupted by noise presented.

The problem of estimation of signal parameters is formulated as an optimization problem and solved by using the gradient descent continuous-time method. Basing on this approach were systems of nonlinear differential equations developed, that can be implemented by analog adaptive neural networks. The developed networks contain elements which are similar to the adaptive threshold elements of the perceptron presented by Widrow in [3].

II. Statement of The Problem

When estimating the basic waveform of short-circuit currents the exponential DC component distorts the results. In this case the sinusoidal signal model has to be extended with an exponential term:

$$x(t) = X_a \sin(\omega t) + X_b \sin(\omega t) + X_c \exp(-\mathrm{X_d} t) \quad (1)$$

in which

X_a , X_b are the amplitudes of the sinusoidal component,
$\omega = 2\pi \mathrm{f}$ where f is the frequency,
X_c, X_d are the parameters of the DC component.

Let y(t) denote the noise corrupted measurement of *x(t)*, i.e.

$$y(t) = x(t) + e(t) \quad (2)$$

where *e(t)* is the unknown error including random noise and distortion caused, for example, by measurement instruments or higher harmonics.

Consider the practical case where the signal of interest *y(t)* is measured during a finite duration of time and only N samples of the signal $y(t)|_{t=mT} = y(mT) = y_m$, are available. Hence, the error e_m can be expressed as

$$e_m = y_m - x_m \quad (3)$$

where $x_m = x(mT)$, and T is the sampling interval.

There exists a need for an online algorithm that can directly provide estimates of the parameters on the basis of the given data samples y_m. To solve the problem using artificial neural networks, the key step is to construct an appropriate energy function E(**X**), so the lowest energy state corresponds to the desired solution. The problem can be formulated as to find a vector **X** which minimizes the scalar energy function

$$E(\boldsymbol{X}) = \sum_{m=1}^{N} \sigma_m \left[e_m(\boldsymbol{X})\right] \quad (4)$$

where $\sigma_m[e_m(\boldsymbol{X})]$ represents a suitably chosen loss function.

In practice, the following cases have special importance [3-5]:

1) for $\sigma_m[e_m] = |e_m|$ the estimation problem is referred as the least absolute value signal model fitting;
2) for $\sigma_m[e_m] = e_m^2$ is the standard least-squares optimization problem obtained;
3) for $\sigma_m[e_m] = k_m e_m^2$, with $k_m > 0$, the estimation problem is referred as the well-known weighted least-squares optimization problem.

The proper choice of the optimization criterion used depends on the distribution of the noise error in the sampled data. The standard least-squares criterion is optimal for a normal (Gaussian) distribution of the noise. Often, the signals of voltages and currents encountered in power systems are notoriously contaminated by impulsive noise and large isolated errors (outliers) caused by malfunctioning of some sensors or transient components. To reduce the influence of the outliers the iteratively reweighted least-squares criterion can be used.

III. Estimation The Amplitudes of The Basic Components

Fast estimation of parameters of the basic components of voltages and currents from measured data is very important for measurement, control and protection tasks in electrical power systems. It is difficult to filter out frequency components close to the fundamental frequency, without delaying the filter response.

In this section an adaptive neural network for estimation the amplitudes X_a and X_b of distorted sinusoidal signals has been proposed.

The neural network was developed according to the signal model

$$x(t) = X_a \sin(\omega t) + X_b \cos(\omega t) + \mathrm{e} \tag{5}$$

As a loss function in (4) the standard least-squares optimization criterion has been chosen. The function E(X) can be minimized by implementing the steepest descent optimization algorithm

$$\frac{d\boldsymbol{X}}{dt} = -\frac{1}{\tau}\nabla E(\boldsymbol{X}) \tag{6}$$

where τ is the integration time constant and

$$\nabla E(\boldsymbol{X}) = \left[\frac{\partial E(\boldsymbol{X})}{\partial X_a};\frac{\partial E(\boldsymbol{X})}{\partial X_b}\right].$$

The gradient system can be rewritten in a scalar form as a system differential equations:

$$\frac{dX_a}{dt} = -\frac{1}{\tau}\sum_{\mathrm{m}=1}^{\mathrm{N}} \mathrm{e_m} \sin(\mathrm{m}\omega\mathrm{t}) \tag{7}$$

$$\frac{dX_b}{dt} = -\frac{1}{\tau}\sum_{\mathrm{m}=1}^{\mathrm{N}} \mathrm{e_m} \cos(\mathrm{m}\omega\mathrm{t}) \tag{8}$$

The above system of differential equations can be implemented by an adaptive analogue neural network, as shown in Fig. 1. The network consists of basic computing units: integrators, summers and multipliers. The network estimates the amplitudes of the basic components of signals.

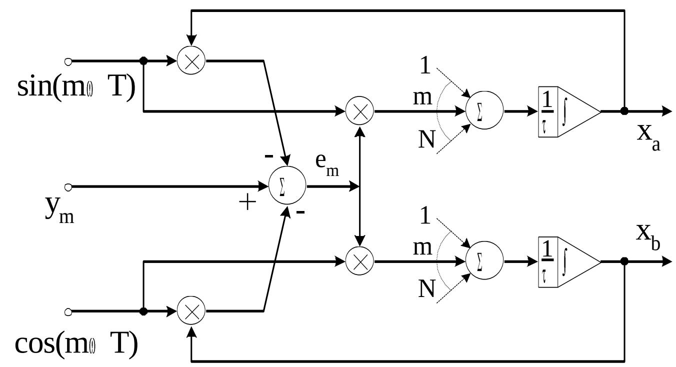

Figure 1. Artificial neural network with two neurons for estimation the amplitudes of the basic component.

IV. Application of Neural Network

The laboratory tests utilize simulation of neural networks principles using Matlab Simulink environment [6]. Students taking a part in exercise are aimed at constructing a proper model of neural network according to accepted optimization criterion (Section II). Simultaneously, they have an occasion to improve their knowledge about parallel signal processing. The structure of modeled network applies typical elements: adders, multiplexers, integrators and generator of trigonometric functions. The main kernel of the scheme is based on two integrators associated with N signal channels. Optimization process serves calculation of basic component parameters: amplitude and phase.

Described exercise brings many didactic benefits to students. Starting from wide knowledge about different architectures of neural networks, through selection of optimization algorithm associated with noise level in investigated signal, to adaptation of sampling circuits and selection of suitable neural network structure.

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Digital Filters in Students Laboratory

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***Abstract*- This paper described an education laboratory to design and implementation of digital filters in the packet with the signal processor. In first part of exercise the program Matlab is used to analising and filter design, then the code of the program is converted to the environment Code Composer Studio. After starting the program on the processor, physical filter characteristics is taken off, and then compared with suitable theoretical characteristics. Integrating the project with the practical realization allows for the better understanding of theoretical aspects design and implementation of digital filters.**

I. Introduction

Texas Instruments offers from the longer time various DSP Starter Kit (DSK). It is complete systems to the digital processing of signals [4]. The environment programistic Code Composer Studio (CSS) is the element of these sets.
It contains the compiler of the language C and C ++, debugger, linker and loader. It promises an effective way to design and implement a variety processing algorithms for real-time applications.
Digital filters design is the folded question. It hugs the results of theoretical investigations in the range of the signal processing. He also has to consider the possibilities of the practical realization of algorithms.

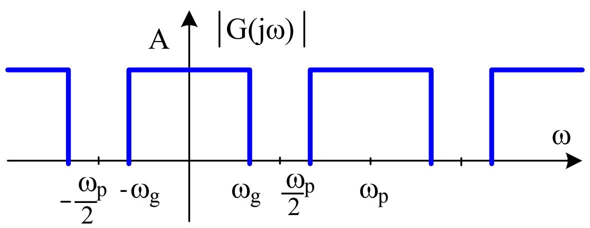

Figure1 Magnitude response of ideal low pass filter

Filters received on the basis of a Fourier series method are often applied. Figure 1shows transfer functions |G(jω)| ideally represented for the low pass filter.
The desired transfer function as the Fourier series can be written as

$$G(j\omega) = \sum_{k=-\infty}^{\infty} g_k \, e^{-jk\omega T} \qquad (1)$$

we arrive coefficients g_k directly from

$$g_k = \frac{T}{2\pi} \int_{-\frac{1}{2}\omega_p}^{\frac{1}{2}\omega_p} G(j\omega) e^{jk\omega T} d\omega = 2A \frac{f_g}{f_p} \frac{\sin\left[2\pi \frac{f_g}{f_p} k\right]}{2\pi \frac{f_g}{f_p} k} \qquad (2)$$

Where fp is sampling frequency and fg a cutoff frequency

The example of impulse response an low pass filter with f_p=10 kHz, f_g=700 Hz, A=1 on figure 2 is presented

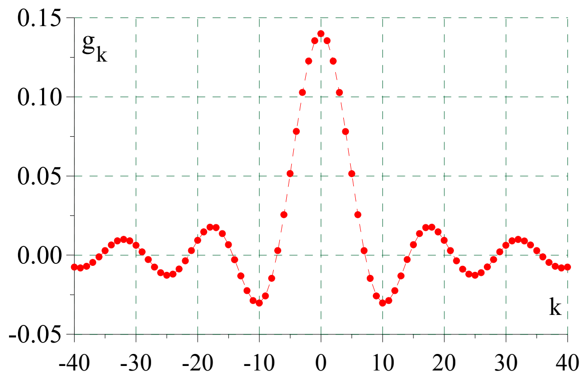

Figure 2 Output impulse response of ideal filter

The equation (1) describes the non-casual filter characteristic whose the output impulse response (2) has an infinite number of samples. In order to obtain a realizable filter, we must truncate (1), which yields the approximated transfer function

$$H_N(j\omega) = \sum_{k=0}^{N-1} h_k \, e^{-jk\omega T} \qquad (3)$$

where N is finite order of the filter.
Filter coefficients (3) h_k (k = 0, 1, 2 … N-1) are a part of coefficients of ideal filter.

$$h_k = g_{k-k_0} \quad \text{for } k \geq 0 \qquad (4)$$

where k_0 – some starting position of g_k

We get filters differing the quality of the approximation of the ideal characteristic and dynamic proprieties in dependence from the choice of the position k_0. The best, under in relation to the quality of the frequency characteristic, there is the filter with coefficients g_k laid symmetrically to k=0. This obvious fact, from the didactic point of the view, he makes up the illustration of the meaning of the proper selection of coefficients and his influence on the quality of the filtration. Procedure of reduce the number of coefficients can be compared to placing a window of width N over all of the ideal coefficients. All coefficients within the window are retained and all coefficients outside of the window are ignored. However, the abrupt truncation of the filter coefficients has an adverse effect on the resulting filter's frequency response, exhibits height sidelobes or oscillation, specifically, near discontinuities. Therefore, a number of other window functions have been proposed which smoothly reduce the coefficients to zero. The retained values of the filter coefficients would be determined by performing a coefficient by coefficient multiplication of the ideal coefficients and the window coefficients as indicated in equation (5)

$$h(k)=h_{ideal}(k)\ w(k) \qquad k=\pm1,\pm2... \tag{5}$$

w(k) are a window coefficients
A number of window functions are currently avilable e.g. window of Blackman, Hamming, Bartlett, Kaiser etc.
For example the Blackman window is defined as

$$w[k] = 0.42 - 0.5\cos\left(\frac{2\pi k}{N-1}\right) + 0.08\cos\left(\frac{4\pi k}{N-1}\right) \tag{6}$$

$k \in <0, N-1>$

II. Design and Implementation of FIR Filters

As it was described in the introduction, this activities consists of two parts. In the first part, students using MATLAB for designing digital filters. This environment has many function for example the function *fir2()*. Fir2(N,F,A) designs an N'th order FIR digital filter with the frequency response specified by vectors F and A, and returns the filter coefficients in length N+1 vector B.Vectors F and A specify the frequency and magnitude breakpoints for the filter [5]. Filter coefficients from vector B are saved as text file on hard disc and included to the program in language C for signal processor. The example code of the programme was showed below {6}

```
#include "wsp.cof" //coefficient file
int yn = 0; //initialize filter's output
short dly[N]; //delay samples
interrupt void c_int11() //ISR
{
short i;
dly[0] = input_sample(); //newest input @ top of buffer
yn = 0; //initialize filter's output
for (i = 0; i< N; i++)
yn += (h[i] * dly[i]); //y(n) += h(i)* x(n-i)
for (i = N-1; i > 0; i--) //starting at bottom of buffer
dly[i] = dly[i-1]; //update delays with data move
output_sample(yn >> 15); //output filter
return;
}

void main()
{
comm_intr(); //init DSK, codec, McBSP
while(1); //infinite loop}
```

Figure 3 shows magnitude characteristic of desired and real FIR filters

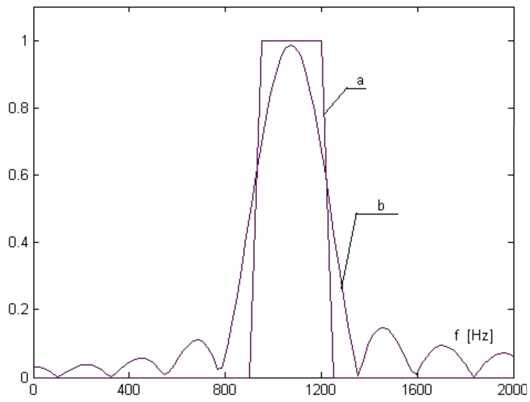

Figure 3 Magnitude response of desired (a) and actual (b) FIR filters

After starting this program, on the input A/C converter are given sinusoidal signal from generator. Amplitude of signals are exactly the same as amplitude of samples for function in Matlab for the same frequency.

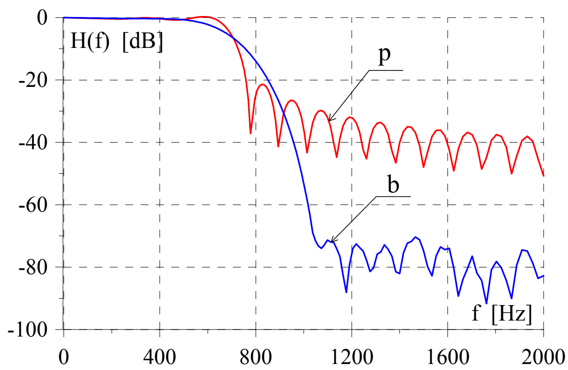

Figure.4 Magnitude characteristics of filters with the rectangular window(p) and Blackman window (b)

In the correctly executed exercise measurement and theoretical values are practically the same, it is on figure 4 shows. Practice realized in the form of the project gives the possibility of the change of various parameters and the observation of their influence on different characteristics.

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Numerical calculation of varistor model for sinusoidal signal

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***Abstract*- ZnO varistors are semiconductor devices with highly nonlinear current-voltage characteristic and are widely used as devices for overvoltage protection. Varistor applications range from the use of small varistors to protect electronic components to large varistors for protection of power systems. This paper presents proposed model of ZnO varistor and methodology of its mathematical analysis and simulation. The mathematical analysis of the proposed model makes it possible simulate the current trace on a nonlinear element.**

I. INTRODUCTION

Varistors are ceramic elements whose current-voltage characteristic is highly nonlinear. The varistors are usually manufactured in the ceramic process in which pressed zinc oxide with admixtures of other metallic oxides is sintered. A matrix made up of ZnO grains enclosed by an intermediate (intergranular) layer composed of dissolved oxide admixtures forms the obtained microstructure [1].

The varistor effect is produced by phenomena, which occur at grain boundaries in the varistor's microstructure. The Schottky potential barrier is generally regarded as playing a key role in current conduction in this system [2].

Numerous, more or less complicated ZnO varistor models can be found in the literature [3-5]. The simplest model consists of a capacitance and a nonlinear resistance connected in parallel.

The simple ZnO varistor model proposed here taking under account that the additional impedance due to the finite conductance and capacitance of the intergranular phase has a significant effect on the model response. Thus that model can be presented as [6]:

- the nonlinear resistance of intergranular boundaries and the linear capacitance associated with the impoverished region, and
- the capacitance-resistance impedance associated with the intergranular phase.

II. MATHEMATICAL ANALYSIS OF THE MODEL

Assuming that the waveform of voltage is described by function:

$$u(t)=\sqrt{2}\,sin\,\omega t = Im\left\{\sqrt{2}\sum_{k=1,3,5,\ldots}\underline{U}_{(k\omega)}e^{jk\omega t}\right\} \qquad (1)$$

and $\underline{U}_{(k\omega)}=0$ dla k >1 oraz $\underline{U}_{(\omega)}=U$,

the waveform of current is described by:

$$i(t)=\mathrm{Im}\left\{\sqrt{2}\sum_{k=1,3,5,\ldots}\underline{I}_{(k\omega)}e^{jk\omega t}\right\} \qquad (2)$$

Mathematical analysis the equivalent circuit are based on the superposition method.

Analyzing the system for the k-th harmonic, the equations for the k-th harmonic assume form:

$$\underline{U}_{(k\omega)}=\underline{Z}_{A(k\omega)}\underline{I}_{(k\omega)}+\underline{U}_{N(k\omega)} \qquad (3)$$

$$\underline{I}_{(k\omega)}=\underline{Y}_{B(k\omega)}\underline{U}_{N(k\omega)}+\underline{I}_{N(k\omega)} \qquad (4)$$

The varistor model described by analytical model has been implemented in the Matlab environment. The diagram of model implementation is shown in Fig. 1. The results of simulation are shown in Figures 2-3. These trajectories are compared to trajectories of real varistor, shown in Figures 4-5. Comparing figures 2 and 3 with figures 4 and 5 it was found that there is large agreement (compatibility) between current i(t) waveform received from simulation and received from real object. This calculation could described the influence of odd harmonic content in voltage waveform on the current waveform as described in [7].

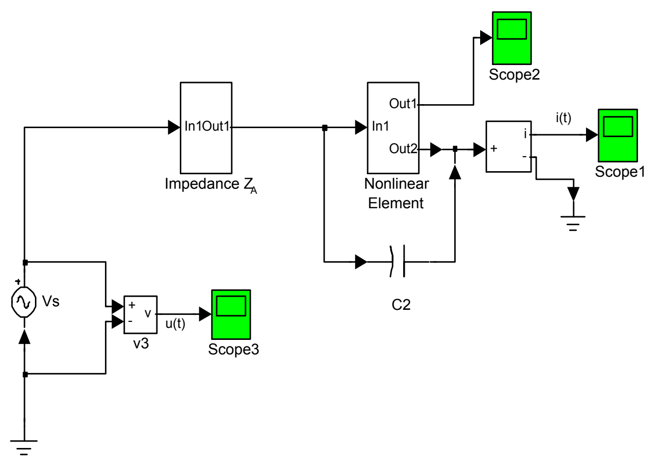

Figure 1. Analytical model implemented in the Matlab programme

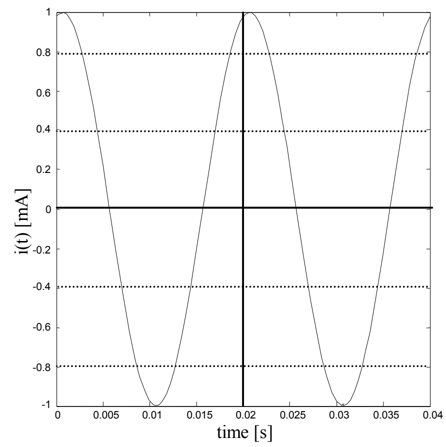

Fig.ure 2. Calculated curve i(t) for analytical model, U<<Uref.

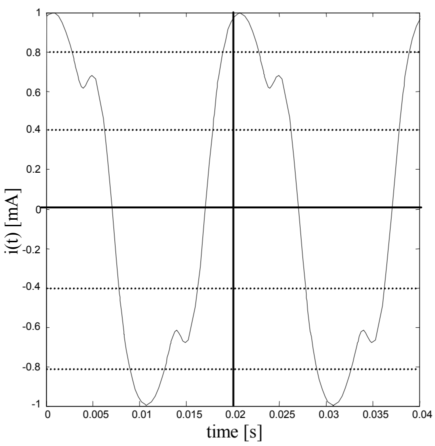

Figure 3. Calculated curve i(t) for analytical model, U>Uref.

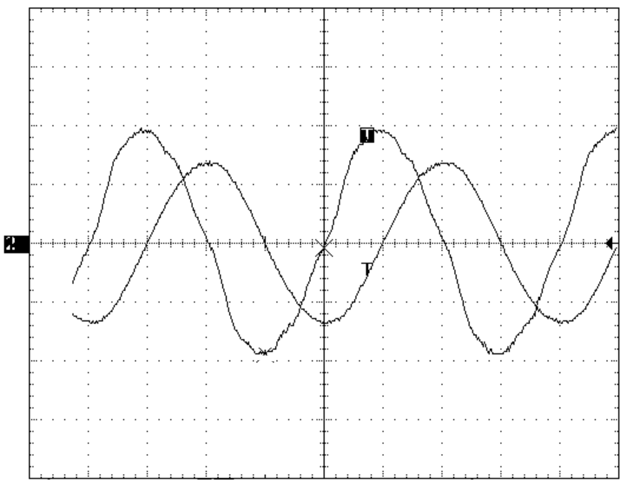

Figure 4. Trajectories of current i(t) and applied voltage u(t) of real ZnO varistor for $U \ll U_{ref,}$

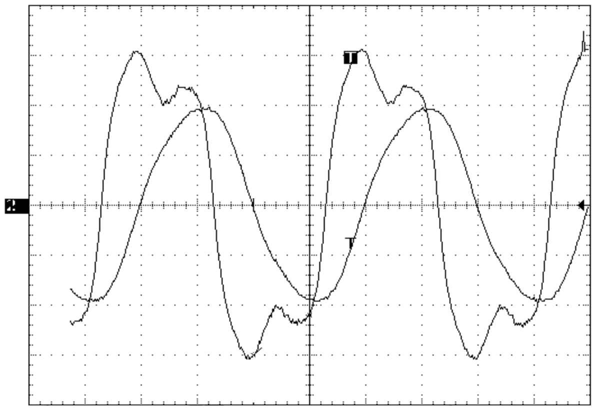

Figure 5. Trajectories of current i(t) and applied voltage u(t) of real ZnO varistor for $U > U_{ref,}$

III. CONCLUSIONS

The numerical calculation of proposed analytical model are strong convergence with results from real object. It shows, that method of solution of model is proper. Moreover the solution of the analytical model based on the superposition method makes it possible to determine the current waveform on a nonlinear element.

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[7] M. Jaroszewski, "Analyzing of varistor model response for sinusoidal signal with harmonics", EEEIC Conference on Environment and Electrical Engineering, 5-10 May 2008, in press

Analyzing of varistor model response for sinusoidal signal with harmonics

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***Abstract-* In this paper the effect of harmonics content in the voltage signal on the varistor model response is analysed using Matlab computer simulations. It is shown that that the harmonics content in the supply voltage can be a source of errors in the measurements of the varistor conduction current.**

I. INTRODUCTION

Varistors are ceramic elements whose current-voltage (I-V) characteristic is highly nonlinear. At relatively low voltages (U<<Uref) the varistor have almost ohmic conductivity. At higher voltages (U>Uref) the current increases dramatically with voltage. Highly nonlinear characteristic of this regime of rapid increase is generally described through the nonlinear coefficient α, defined by equation:

$$I = cU^{\alpha} \tag{1}$$

The coefficient α (varies with voltage) can attain values well in excess of 50 in modern varistors.

Equivalent circuit diagrams of oxide varistors are made to analyse their service performance. Numerous equivalent circuit diagrams of ZnO varistors can be found in the literature on the subject [1-4]. They differ in their complexity, the kind of voltage shape used or the limitation of description to a particular range of the voltage-current characteristic. For alternating voltages lower than U_{ref}, in such models the equivalent circuit diagrams usually have the form of connections between both linear and nonlinear elements R and C.

II. SIMULATION

Computer simulations were run using the varistor model described in [4]. Numerical calculation of the model is described in [5]. The computations were performed using an application running in the Matlab Simulink environment. The implementation of the program is shown in Fig. 1. The application was designed to perform analysis of the current signal waveform when the input voltages are lower than U_{ref}. In this range of applied voltages, the varistor current is practically sinusoidal (capacitive).

The investigations were carried out for different odd harmonics contents in the voltage signal. The results of the simulations are shown in Figures 2-5. The results of a Fourier analysis of the third harmonics content in the varistor current response to the excitation voltage are shown in Fig. 3 and Fig. 5 (arrowed).

Figs 2 and 3 show respectively: the varistor current response and the third harmonic content in the studied current signal when the supply voltage is sinusoidal, without odd harmonics. As is shown, current is sinusoidal without harmonics.

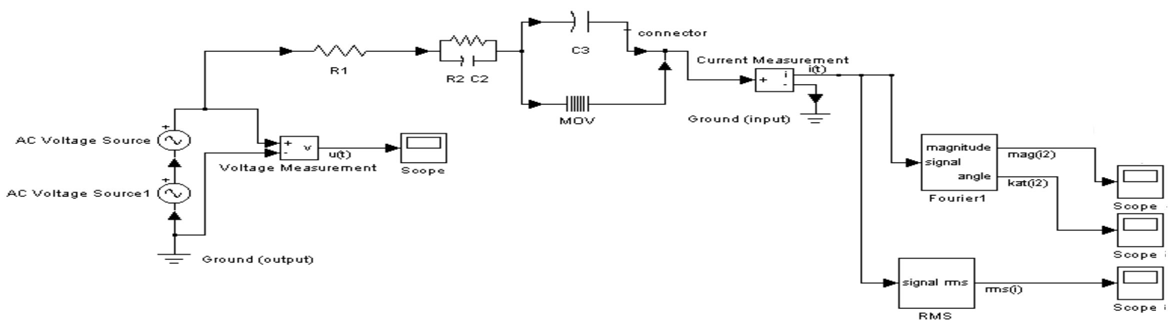

Figure 1. The implementation of varistor model in Matlab.

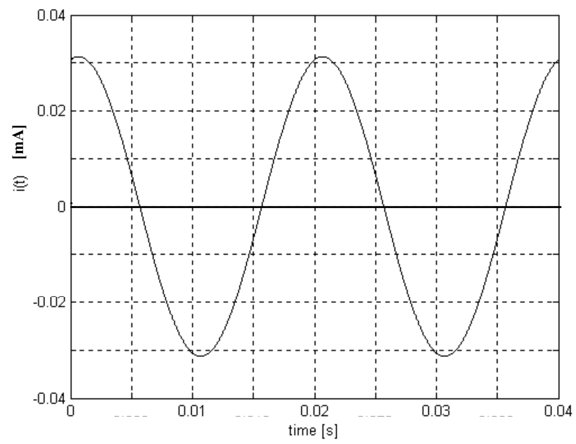

Figure 2. The varistor current (supply voltage U is sinusoidal)

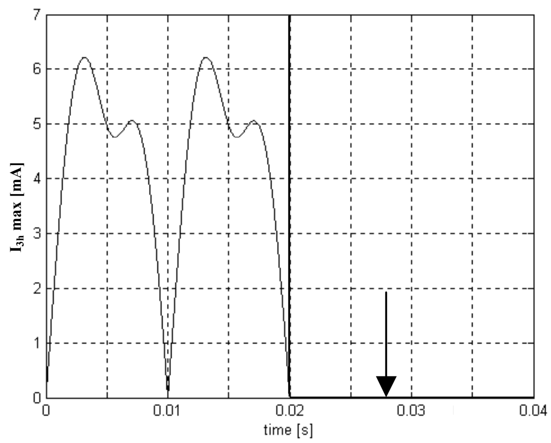

Figure 3. The magnitiude of 3th odd-harmonic of the varistor current (supply voltage U is sinusoidal).

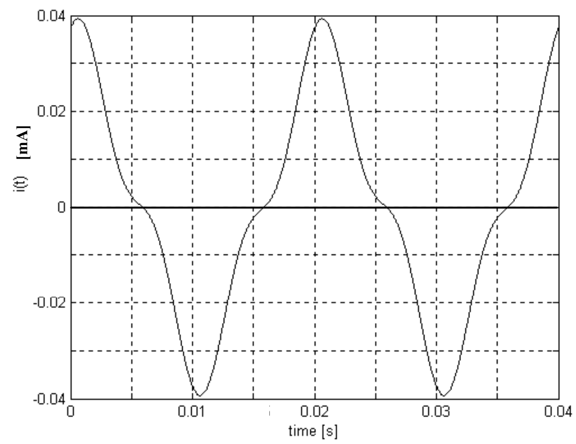

Figure. 4. The varistor current (supply voltage U is distorted by 3th odd harmonic).

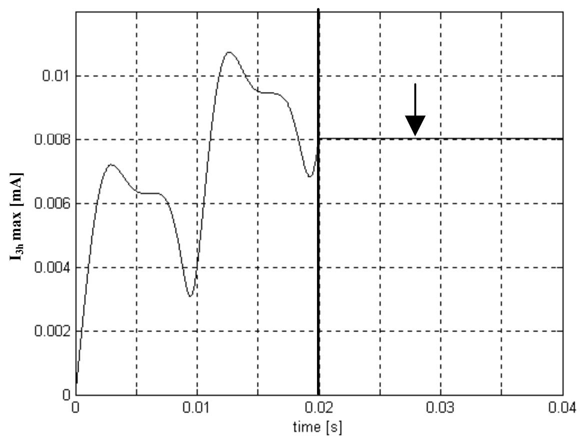

Figure 5. The magnitiude of 3th odd-harmonic of the varistor current (supply voltage U is distorted by 3th odd harmonic).

Figures 4 and 5 show the simulation results for a case when higher harmonics are present in the voltage with the same magnitude. The third harmonic is clearly visible in the varistor current signal. The peak value of current is changes due to presence of 3 th harmonic.

III. CONCLUSIONS

If higher harmonics appear in the supply voltage they cause presence of harmonics in the current and changes in current peak value. It is very important source of errors in the measurements of the varistor conduction current.

It should be noted that stable Fourier analysis results (arrowed) were obtained after 20ms since the beginning of computer simulation.

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[5] P. Kostyła, "Numerical calculation of varistor model for sinusoidal signal", EEEIC Conference on Environment and Electrical Engineering, 5-10 May 2008, in press

Mechanical-Acoustic Examination of Ceramic Material

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Abstract **The paper presents a new mechanical-acoustic method of research of material degradation. As comparative method there was used microscopic technique (MO). Examinations were carried out on the samples of C 130 kind porcelain cut out from the rod of typical HV line insulator LP 75/31W. On the basis of acoustic emission (AE) measurements of slowly compressed samples, the successive stages of structural degradation have been registered.**

I. Introduction

Acoustic method is suitable for the investigation of the destruction of ceramic materials, due to the fact that initiation and growth of microcracks belong to the main sources of AE signals. Examination of alumino-silicate and corundum ceramic materials enabled to state that the sum of AE events during the loading period is a good descriptor of the intensity of the processes of cracking, which are the cause of mechanical degradation of the material. There exists a correlation between the rate of the increase of cracks and the rate of AE events [1]. Registration of this descriptor allows monitoring the process of destruction of the microstructure of a ceramic material under load. The authors stated as well good correlation between the processes of material structure degradation, mainly connected with microcracks development, and the AE activity represented by the effective value of AE signal (RMS). There exist serious analogies between the effects of many years' exploitation under load applied to the material and the compressive stresses in a relatively short lasting laboratory test.

The authors are developing method of mechanical-acoustic testing of the ceramic materials. This method, together with comparative microscopic analysis of material structure, was employed for investigation of corundum material [2] and samples of the porcelain. Examinations performed on the electrotechnical porcelain C 120 kind had special importance. Comparing the structural degradation of the material of operated insulators and laboratory compressed samples, significant similarity was established [3]. Structural effects of slowly increasing compressive load applied to the material and aging processes, being result of many years of exploitation on power line, appear similar.

Application of the acoustic emission method enabled to distinguish two stages of material degradation, considering clearly separated intervals of acoustic activity. The first stage of the material degradation occurs as a result of internal stresses existing in the ceramic body, mainly in the micro scale, created during the manufacturing processes. The process of increase of these defects has relatively low threshold and they can develope already at lower stress of the sample. The process of microcracks propagation under exploitation conditions, however, is slow and takes many years. The second stage of AE activity corresponds to long lasting development of subcritical defects. Damage of quartz grains, precipitations of mulite and cracks in glassy matrix develope gradually. The process of dekohesion is partly stopped, microcracks are branched on phase boundaries. Overcoming of each of these boundaries requires some energy. Only under sufficiently high load, there takes place a process of the propagation of big cracks, which precedes the disintegration of the sample. These effects find distinct reflection in AE activity. The single cracks join together in the process of time, and after branching out they lead to the development of a network of cracks and finally the destruction of the object – Figure 1.

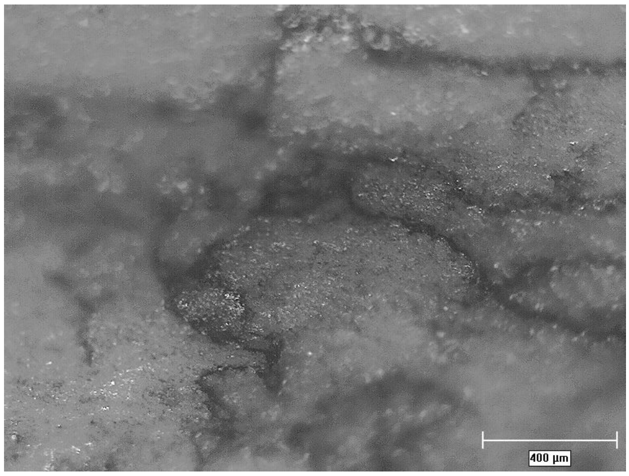

Figure 1. Cross-section of a sample loaded up to the beginning of critical stage of structure degradation (about 400 MPa), magnification 50x. Branched cracks in the central part of the sample are visible.

Similar investigations were carried out also on specially prepared samples of porcelain C 130 kind. These tests were performed on small specimens containing fine, medium or numerous structural defects [4]. Examination was aimed to recognize influence of technological faults in the material structure on mechanical-acoustic characteristics and mechanical strength of the porcelain samples. It was found that the presence of areas of high internal stresses favours the generation and propagation of cracks, which causes the decrease of the strength of the samples by some tens of percent. This refers to areas with disturbed texture as well as fissures and densely distributed large pores. The non-homogeneities of the distribution of mullite precipitates and particularly of quartz grains are definitely less important. The mechanical strength of the material is determined primarily by the properties of the glassy matrix, containing a lattice of tiny, needle-shaped crystals of mullite and densely distributed fine grains of corundum. Even samples containing significantly defected structure, such as macroscopic textural defects, demonstrated relatively high compressive strength, exceeding 50 % of strength of specimens without defects. Mechanical-acoustic characteristics of a sample with big structural faults is presented on Figure 2.

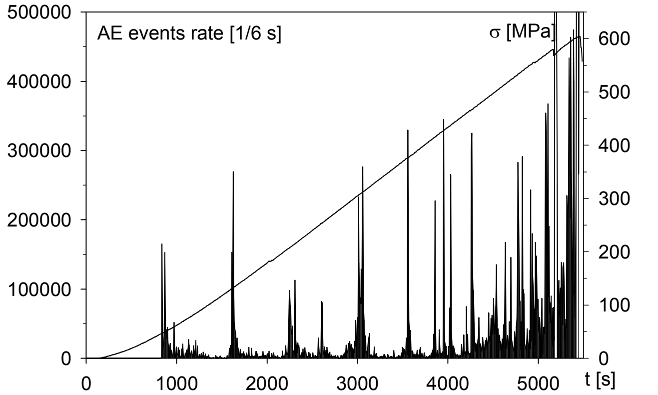

Figure 2. Course of AE events rate for a sample containing serious textural faults, which was destroyed at the stress 604 MPa. The continuous acoustic activity and high level of signals is observed.

II. RESULTS AND DISCUSSION

The most recent investigations of the porcelain material C 130 kind were performed on the samples cut off from the rod of typical HV line insulator LP 75/31W (2006). Purpose of this work was registration of the stages of structural degradation of the insulator's material. Relatively short period of operation of products made of the material C 130 kind has not yet allowed obtaining sufficient information about ageing degradation in this type porcelain. Although production of this porcelainin the domestic industry began in 1979 (material denoted E-15), it became widely applied only in 1990s. Aluminous materials belonging to the triple system K_2O-Al_2O_3-SiO_2 have in general a similar composition of raw materials. In spite of that, the porcelains of C 120 and C 130 types differ from each other significantly in structure and the mechanical parameters. The investigation results, obtained up to now, seem to indicate a different character of the development of cracks in the material C 130 in comparison to typical aluminosilicate materials (including porcelain). This is the result of effective reinforcement by corundum and mullite phases. For these reasons, the results of investigation, carried out for other aluminosilicate materials, including the C 120 material cannot be applied to porcelain of C 130 kind.

Mechanical-acoustic tests were carried out using specially constructed two-channel measuring system – Figure 3. The mechanical channel contained testing machine INSTRON 3382 with computer control. The steel base, on which the sample was placed, functioned simultaneously as an acoustic waveguide. Velocity of the traverse of the machine equal to 0.02 mm/min was applied. Simultaneously with the measurement of the load acting on the sample, AE descriptors were recorded. The acoustic measurement path contained a broad band transducer, preamplifier, AE analyzer and computer.

Structural investigations of the effects of degradation of the material structure were carried out on several selected samples. Their loading was stopped after acting different compressive forces. The most important was examination of the samples, which were stressed up to the beginning of the critical stage of structure degradation. On Figure 4 there was presented typical mechanical-acoustic characteristics of the sample of C 130 kind insulator porcelain under compressive stress.

There were registered only very weak signals corresponding to the preliminary stage of the material degradation. These effects were recognized as the result of separation from matrix fragments of the porcelain cullet and grains of quartz. Threshold energy of these AE sources is such low, that signals could be hardly recorded. Next stage takes place at the stress of several hundreds of megapascals. This phase, named as subcritical, corresponds to long lasting effects of cracks development in the agglomerations of corundum grains. Particular grains are separated from matrix due to peripheral cracks growth. While stress increases, more number of grains inside the agglomeration becomes separated and cracks are getting longer. Simultaneously microcracks are initiated and grow inside big precipitates of mullite. Their parts are being surrounded by increasing microcracks. Cracks development in the matrix is however effectively hampered by strong structural reinforcement. This role play densely distributed fine grains of corundum and needle-shaped small crystals of mullite, acting as armament of the structure. AE effects of subcritical phase form single signals and occasionally intervals of continuous acoustic activity at differentiated values of stress. Structure of the material loaded up to advanced subcritical stage was presented on Figure 5.

The AE activity corresponding to the critical stage of material degradation is continuous and has much higher energy than in case of the earlier ones. Large cracks are growing especially in the middle part of samples, where the stresses become cumulated. The critical interval is comparatively short and characterized by a good repeatability of energy level of AE signals.

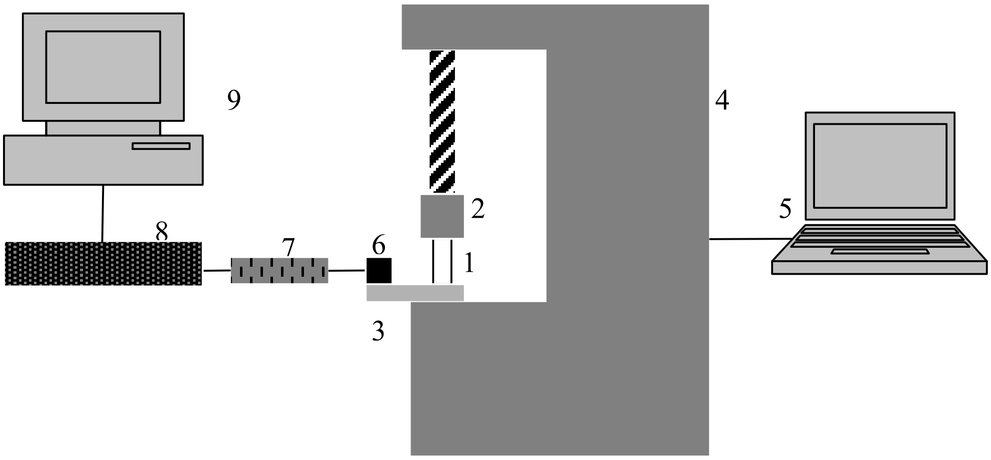

Figure 3. Scheme of a double-channel measuring system for mechanical-acoustic investigation of ceramic samples: 1 – porcelain specimen, 2 – traverse of the testing machine, 3 – steel base functioning as AE waveguide, 4 – testing machine INSTRON 3382, 5 – computer controlling operation of the machine, 6 – AE transducer WD PAC type, 7 – preamplifier, 8 – AE analyser, 9 – computer recording AE descriptors.

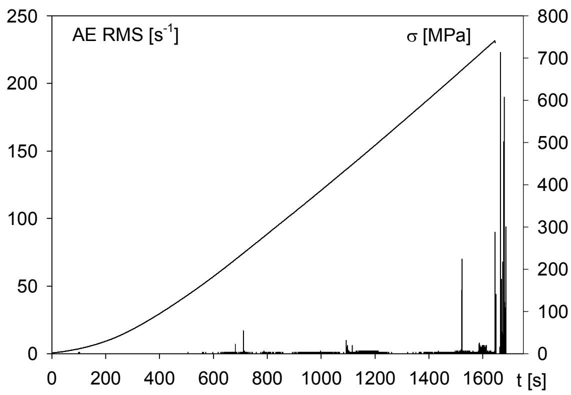

Figure 4. The course of RMS AE rate versus the increase of compressive stress for the C 130 insulator porcelain sample. Loading was stopped at 741 MPa, just before destruction.

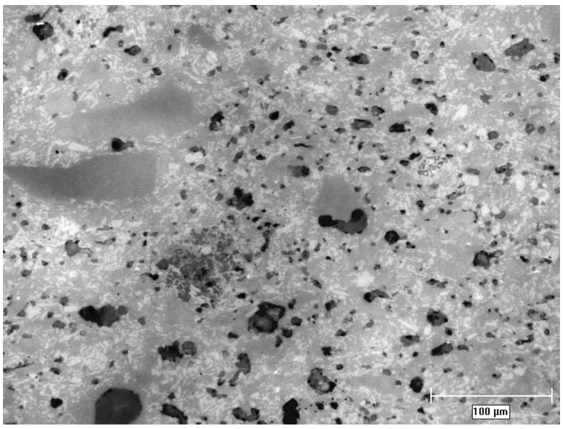

Figure 5. Structure of C 130 kind insulator material loaded up to 728 MPa. Shady areas of various shape and size represent damaged agglomeration of corundum, crushed out grains of quartz and destroyed parts of precipitates of mullite (darker grey fields).

The stages of material degradation, presented above, in the opinion of the authors take place during many years' period of operation of insulator on overhead power line. Mechanical-acoustic method, used together with comparative microscopic technique, enables description of the ageing processes in exploited insulator porcelain material.

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Ultrasonic Non-Destructive Diagnostics of HV Insulators

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Abstract- **The paper presents non-destructive ultrasonic method for investigations of long-rod insulators, operated on overhead power lines and stations. It was established correlation between the degree of C 120 porcelain material degradation and the parameters of ultrasonic wave propagation and attenuation. As example of application of the method there were presented ultrasonic examinations of two groups of insulators – 15 line and 49 station post. On the basis of the measurements advancement of ageing degradation of the material and the quality of the tested insulators were ascertained.**

I. INTRODUCTION

The acoustic method is based on the dependence of the parameters of waves' propagation on the properties of the medium, where the waves propagate. In case of a solid body they depend on the elastic properties of the material, as well as on its structural composition. The ultrasonic method has been widely applied in flaw detection. Detecting the discontinuities of the medium is performed by introducing a wave beam into investigated material and then recording its reflection from the boundary. Among possible applications of ultrasonic method, very important is elastometry. On the basis of experimentally determined values of the velocities of longitudinal – c_L and transversal – c_T ultrasonic waves, as well as known material density ρ, it is possible to obtain Young's modulus E and Poisson's ratio ν values [1]:

$$E = \rho c_T^2 (3c_L^2 - 4c_T^2)/(c_L^2 - c_T^2) \qquad (1)$$

$$\nu = (c_L^2 - 2c_T^2)/2(c_L^2 - c_T^2) \qquad (2)$$

One of the most important factors, proving the correctness of the ceramic material structure, is porosity. Porosity contents and its parameters have significant influence on mechanical and electrical properties of the insulator porcelain. This effect can be described by lowering of the elasticity modulus. The porosity changes the elastic Young's modulus of the material, and as a consequence decreases the longitudinal velocity c_L as well as transversal c_T. It was proven that velocities of ultrasonic waves' propagation decrease linearly with the growth of porosity contents [2].

An additional significant ultrasonic parameter, which above all allows evaluating the extent of the aging processes in ceramic material, is attenuation. Lowering and deformation of the signal amplitudes are a result of energy dissipation. This effect is due to the existence of numerous structural heterogeneities, such as micro-cracks, frequently spaced pores, larger crystalline phase precipitations, as well as areas where mechanical stresses appear and especially if the network of cracks is present. By measuring of the decrease of signal amplitudes, after passing through the insulator diameter in subsequent measured points, and by observing the amplitude distortion, the homogeneity, as well as the quality and degree of aging of the porcelain at the core, can be evaluated. Due to complicated geometry of insulator rod and parameters of the ceramic material, measurements of amplitude attenuation coefficient are often difficult and not reliable. The attenuation of porcelain body can be assessed using indirect method. In such procedure amplitude of the signal passing through the rod diameter is registered. This value can be considered as inversely proportional to the attenuation of the medium.

II. MEASURING SET-UP

The ultrasonic tests of the insulators were performed using specially constructed set-up. Its construction enabled measurements in laboratory and also on-site. Weight and overall dimensions of the apparatus were small and it was equipped with accumulators. Its technical parameters were adopted for testing the elements made of material with high degree of structural degradation. The basic components of the set-up are the transmitting – receiving module, digital oscilloscope and a set of ultrasonic piezoelectric transducers. The sending – receiving module was designed and constructed in the Institute of Fundamental Technological Research of PAS [3].

III. EXAMINATION OF LINE INSULATORS

The authors investigated the group of 15 LP 75/17 line insulators, made of C 120 kind porcelain in 1970s, which were in operation for about 30 years period. Results of the ultrasonic

Figure 1. View of the researcher preparing to test of strain insulators LP 75/17 type on the gate support.

measurements obtained for tested insulators in place of operation were collected in TABLE I [4]. In the table are put values of the velocity of longitudinal wave propagation c_L, signal amplitude A and calculated on the basis of equation (1) elastic Young modulus E. Density of the porcelain, determined using material of damaged insulators of the same type, was equal to $\rho = 2.41$ g/cm^3. Due to geometrical restrictions, being the consequence of the insulators' rod shape, the measurement of the amplitude attenuation coefficient was not possible. The damping of ceramic body was determined using an indirect method, by registering of the signal amplitude in volts. The measured value was inversely proportional to the medium attenuation.

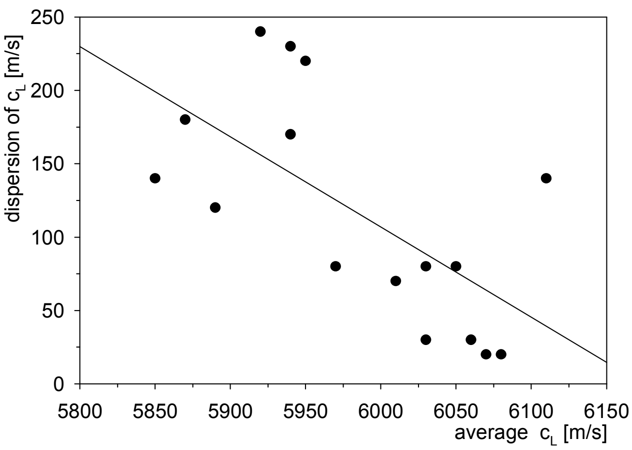

Figure 2. Dependence of dispersion of velocity of longitudinal wave propagation c_L versus average value of c_L for the group of tested insulators.

TABLE I
RESULTS OF THE ULTRASONIC MEASUREMENTS OF THE GROUP OF DOMESTIC INSULATORS LP 75/17 AFTER ABOUT 30-YEARS OPERATION PERIOD.

Ordinal Number	Measured Parameter	Average Value	Range of Value	Relative Dispersion
1	c_L [m/s]	5980	5790÷6180	6.5 %
2	A [V]	3.3	2.1÷4.5	73 %
3	E [GPa]	74	69÷79	13.5 %

Relative dispersion = 100 %·(value$_{max}$-value$_{min}$)/value$_{average}$

The procedure of ultrasonic measurements included tests done at consecutive points between the sheds, as well as next to both fixing devices of each insulator. On Figure 1 there is presented testing of insulators directly in operation. On Figure 2 is shown dependence - range of c_L values measured along insulator rod versus average value of c_L for each insulator.

Dispersion of c_L velocity for individual insulators was situated in the range from 20 to 240 m/s. Average value was equal to 120 m/s. Results indicated considerable diversity of the range of material inhomogeneity along insulator rod in tested group of objects. Dispersion was generally higher for insulators showing lower average c_L value of the material (Figure 2). Elastic module and mechanical strength of these elements were poorer as well. Significant dispersion of material parameters (TABLE I) and its properties are consequence of porcelain constitution and technological factors. Advanced aging processes amplified effect of dispersion. The presence of meaningful defects was not detected in tested group of insulators. Elements containing such faults must have already been broken.

Tested insulators LP 75/17 were characterized by generally not high quality and homogeneity of ceramic material. They were made of aluminous porcelain C 120 kind. Constitution of the material was typical for technology used in 1970s. After about 30 years' period of operation porcelain structure underwent advanced aging degradation processes – Figure 3

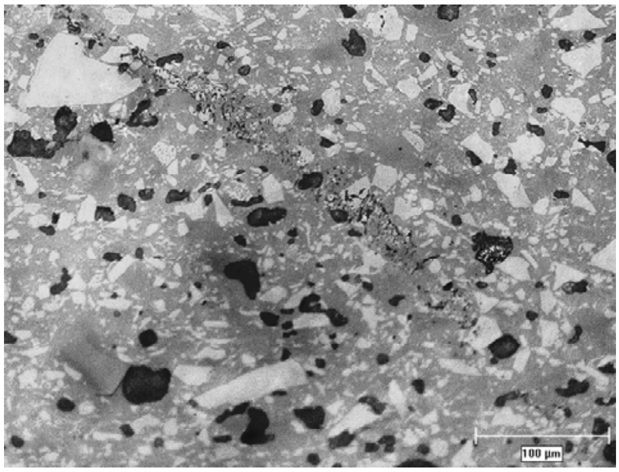

Figure 3. Image of the material structure of LP 75/17 insulator rod from 1973, magnification 200x. High contents of quartz (partly crushed out) – 37 % and band of microcracks are visible.

First of all, it was a consequence of high and diversified contents of quartz phase in the material - between 20 and 37 %, average value 29 %. Quartz frequently occurred as bigger grains (over 30 µm). This phase was the main source of internal stresses, initiation and growth of cracks in the ceramic body. Existence of all sorts of defects or inhomogeneities intensifies aging process of degradation, especially in case of strain insulators' material. Operational stresses have significant influence on intensity of degradation effect. Different material properties in the areas of rod and sheds give evidence of this observable fact. External loads result in considerable enlarging of degradation effects in a rod of line insulators.

IV. Diagnostics Of Station Post Insulators

Besides line insulators, the ultrasonic investigations were also carried out on the group of 56 post insulators, operated on industrial power engineering stations 110/6 kV [3,5]. The insulators SWZPAK-110 type, made in Poland in 1972-1976, underwent ultrasonic measurements. These insulators have been in exploitation for nearly 30 years. Measurements of 49 insulators were performed directly on the isolating switches, one was after breakdown. Further 6 objects came from the station reserve and were taken from the storehouse.

Considering geometrical restrictions, length of ultrasonic signal path and relatively high attenuation of the insulator material, it was necessary to perform series of comparative structural and acoustic tests. This allowed determining correlation between the degree of defectiveness in the ceramic body and measured signal amplitude. The high amplitude values – over 2.2 V, indicate low degree of material aging and lack of structural defects. The values below 1 V are not only the result of the advanced aging processes, but most of all, reveal the presence of faults such as cracks, delaminations or areas characterized by released texture and high, no uniformly distributed porosity in the ceramic body. The most common range of amplitudes - from 1.0 to about 2 V – indicates the lack of significant defects of the material, but at the same time the presence of the aging processes at various stages of advancement. This dependence is confirmed by relatively low values of ultrasonic wave velocities. Results of tests of 56 post insulators are presented in TABLE II.

TABLE II
RESULTS OF ULTRASONIC MEASUREMENTS OF THE GROUP OF POST INSULATORS SWZPAK-110 AFTER ABOUT 30-YEARS' OPERATION PERIOD.

Ordinal Number	Measured Parameter	Average Value	Range of Value	Relative Dispersion
1	c_L [m/s]	5730	5360÷6010	11.3 %
2	A [V]	1.7	0.3÷3.5	188 %
3	E [GPa]	64.5	57÷71	21.7 %

Relative dispersion = 100 %·($value_{max}$-$value_{min}$)/$value_{average}$

It should be emphasized that in the whole group of the tested insulators high dispersion of the material properties was observed. This comes not only from the diversified degree of the material aging process advancement, but most of all from the differences in initial parameters of the electrotechnical porcelain. However, a clear-cut assessment of the tested insulators is difficult, it can be stated that parameters of the material are low and significantly worse than in case of line insulators – TABLE I.

On the basis of measurements there was ascertained similar advancement of ageing processes in the material of exploited insulators and non-operated ones, taken from station reserve. This means that external – operational stresses have low influence on ageing effect in the material of post insulators. Due to this fact, parameters of the material in the area of rod and sheds of insulators are approximately the same.

On the basis of the results of measurements of ultrasonic waves' propagation and their attenuation for a group of 56 SWZPAK-110 insulators from the years 1972-1976, the following facts were ascertained:

- 8 insulators (14.3 %) contained defects, which create high probability of breakdown, one of them underwent breakage;
- 11 insulators (19.6 %) had defects, which cause increased risk of breakdown;
- 37 insulators (66.1 %) contained no detectable defects.

Typical structure of the material of exploited post insulator was presented on Figure 4.

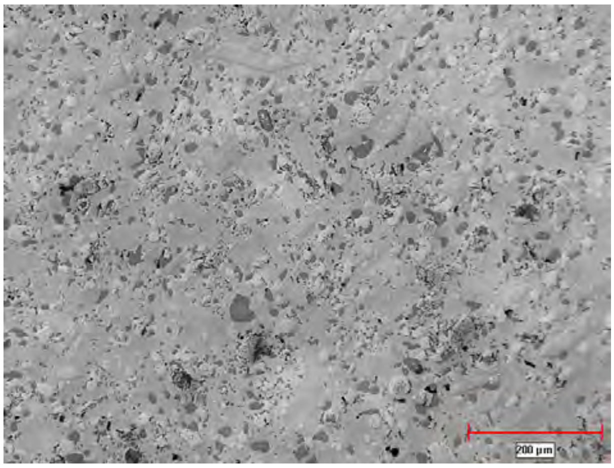

Figure 4. Typical image of the material structure of the insulator SWZPAK-110 rod, produced in the middle of 1970s, magnification 200x. Effect of medium advanced ageing processes - numerous microcracks and crushed out grains of quartz are visible.

The phase analysis of broken SWZPAK-110 insulator material allowed formulating the conclusion that the material corresponds to typical electrotechnical porcelain of C 120 kind, of the older type. Material is characterized by an acceptable homogeneity. The average composition of the porcelain consists of about 24% quartz, over 32% mullite, where 8.5% has the form of needles. The glassy matrix content is about 40%. The presence of corundum crystals in the ceramic body was not detected. The average porosity varies from typical value equal to 3 % to 9 % in defected areas. An important material feature that was ascertained in all areas of the tested insulator is its advanced aging process. This process reveals itself by a large amount of micro-cracks, which are usually adjacent to numerous quartz grains. The latter usually also show cracks. Significant part of grains was completely separated from matrix and was crushed out during polished sections preparation – Figure 4.

V. Conclusions

Tested insulators - line and station post - were characterized by generally not high quality and homogeneity of ceramic material. They were made of aluminous porcelain C 120 type. Constitution of the material was typical for technology used in 1970s. After about 30 years' period of operation porcelain structure underwent advanced aging degradation processes. The most advanced appeared in rods of line insulators. In their case, operational stresses played essential role. For post insulators an external loading had only small influence on aging processes advancement. Reserve post insulators, taken to examination from storehouse, showed unexpectedly similar degree of material degradation as in case of operated insulators. Crucial influence on aging of post insulators' material have internal stresses.

Parameters of the material of line insulators are considerable better than post ones. There were not found any detectable defects in tested line insulators. Material parameters of both examined groups of insulators exhibit high differentiation. This is the consequence of not constant technological conditions and composition of raw material in 1970s. Aging processes strengthened dispersion of porcelain parameters.

For line insulators, it was stated that if the average velocity of ultrasonic waves – measured along insulator rod – was lower, when dispersion of this parameter was higher. This concerns also elastic module values and mechanical strength of insulator material.

Obtained results of ultrasonic and microscopic examinations lead to conclusion that after about 30 years' period of operation, insulators made of C 120 kind porcelain, should be withdrawn from exploitation.

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Resistance of Silicone Rubber High Voltage Insulation to Leakage Current in Modified Inclined Plane Test

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***Abstract*- In this paper results of investigations of resistance to leakage currents of two different silicone rubbers subjected to a modified inclined plate test are presented. The modification of the experiment consisted in a change of the sample's inclination angle and in feeding a moistening solution to the upper surface of the sample. The main aim of the modification was to create laboratory test conditions as close to the ones observed in reality as possible.**

I. INTRODUCTION

Inclined plane test is a well-known standard method of investigation of high voltage insulation materials such as for example laminates or resins which have application in high humidity conditions [1-6]. There are attempts to applying this test for estimate of silicone rubbers, which have hydrophobic properties. In this case a hydrophobic surface of silicone rubber require an artificial modification due to a drops of wetting agent which fall off from the surface.

In the standard method inclination of 45º cause fast flow of wetting agent which prevent wettable path formation and make impossible develop of leakage current.

Due to manufacture technology inclination of upper surfaces of insulator sheds is rather low. Results of inspections of insulators after a few years operating indicated that on the upper surfaces of insulator sheds pollution accumulation was observed. The presence of pollution favoured has developed of partial discharges, which cause of surface erosion.

For these reasons in the modified inclined plane test the upper surface of sample was wetted and the inclination of the samples was changed from 45º to 18º. Described conditions of the test comply with the operating conditions of upper surfaces of the sheds. The experimental setup is shown in Fig. 1.

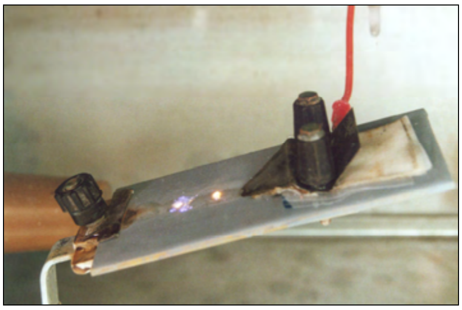


Figure 1. Experimental setup.

II. TEST SETUP AND OBJECT OF INVESTIGATIONS.

The object of the investigations were 3 and 5 mm thick clean samples of HTV silicone rubber and 0,4 mm thick also clean samples of RTV coating, all in the shape of 120x50 mm rectangles.

The test setup for investigating resistance to creeping currents (Fig. 2), described in standard IEC60587, was modified to feed an electrolyte solution at the sample's angle of inclination of 18º corresponding to the inclination of the upper surface of insulators sheds. According to standard [1], the sample should be fixed at an angle of 45º with its tested surface facing downwards. The solution was fed onto fixed layers of absorbent-paper and percolated down to the tested surface.

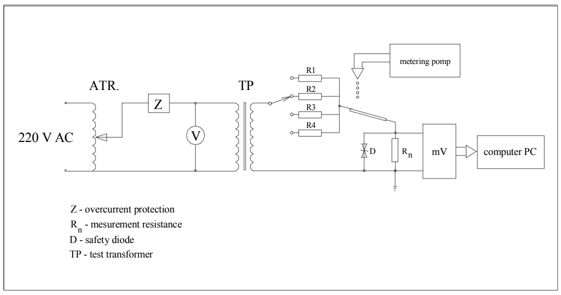


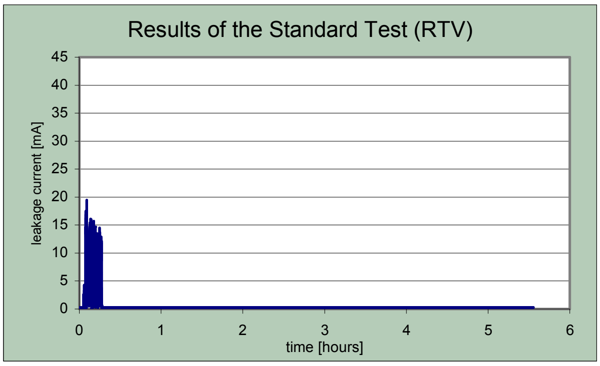
Figure 2. Circuit diagram.

A metering pump metered the wetting agent at a rate of 18 ml/hour. Ammonium chloride used as the wetting agent in the standard test was replaced with a saline solution whose conductivity was 1,5 mS/cm.

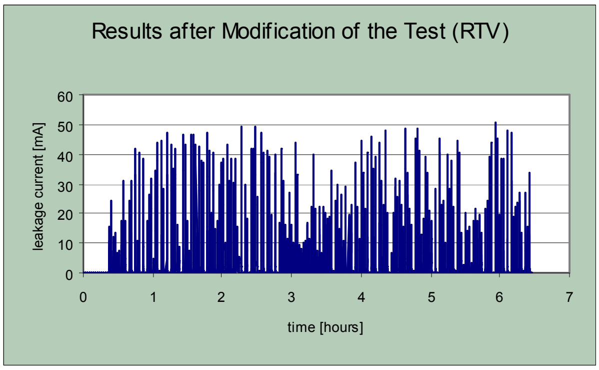
The electric stress was 0,8 kV/cm. During the test, the leakage current was recorded. A sample erosion of 0,2 mm or a recorded leakage current of 60 mA (a flashover could occur at a higher leakage current) was adopted as the end-of-test criterion [1]. If this current level was not reached within 6 hours of testing, the tested material was considered to have passed the test. Earlier investigations of the materials had shown that after 6 hours of the modified inclined plane test the criterion leakage current had not been reached and the differences between the two rubbers had been imperceptible. Therefore in the present investigations material erosion was adopted as the end-of-test criterion.

III. RESULTS OF INVESTIGATIONS

An analysis of the recorded leakage current on the clean HTV and RTV samples shows that the modified inclined plane test does not require special preparation of the surface of the tested materials except for periodic moistening (Fig. 3).



a)



b)

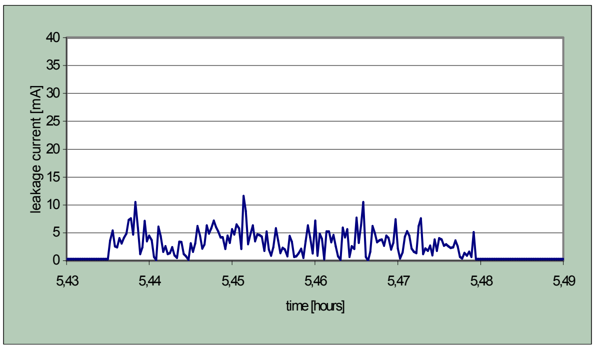
Figure 3. Leakage current versus aging time for RTV samples,

a) the standard test,

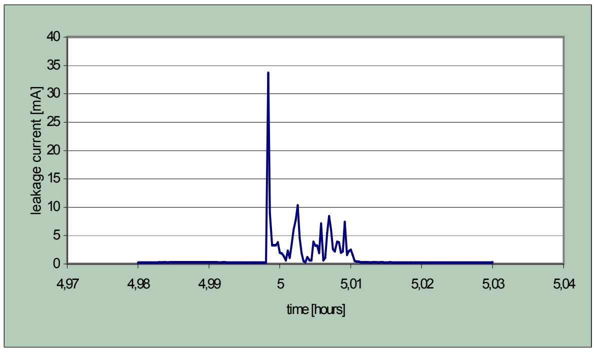
b) the test after modification.

In case of the standard test recorded leakage current value after a few minutes is very low, on a level almost zero. After modification leakage current contains a lot of high separate impulses that indicate on surface discharges occurrence. These results confirm legitimacy of test modification.

The shapes of the currents recorded for the RTV and HTV samples are different (Fig. 4).



a)



b)

Figure 4. Fragment of 3 minutes of leakage current measurements,

a) leakage current versus ageing time for HTV sample,

b) leakage current versus ageing time for RTV sample.

In case of RTV sample the recorded current has the form of separate current impulses with different amplitudes, decaying almost to zero.

In case of HTV sample current impulse ignition occurs periodically and they impulses do not decay but show a growing tendency. The maximum value of a current impulse for the RTV samples was almost 25 mA higher than for the HTV samples. The differences in the shape of leakage current indicate the active suppression of the current by the RTV rubber in the presence of moisture.

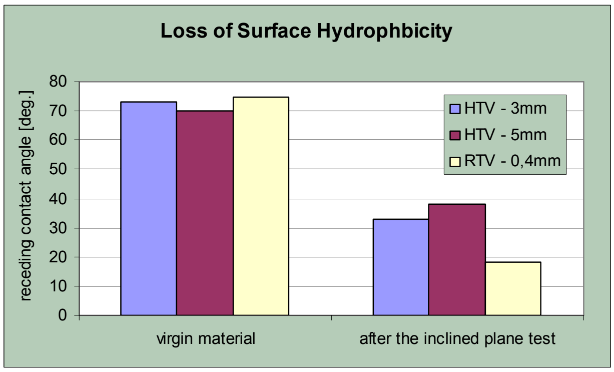
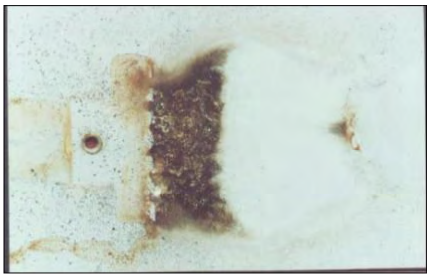


Figure 5. Loss of surface hydrophobicity after the test.

On the Fig. 5 loss of surface hydrophobicity after the test was showed. In case of 5mm thick HTV samples receding contact angle was equal almost 40 degree whereas the worse results were obtain for 0,4 mm thick RTV sample – almost 20 degree.



a)

b)

Figure 6. Surface erosion of tested samples,

a) HTV sample after 53 hours,

b) RTV sample after 36 hours.

The Fig. 6 presented pictures of both type of samples. In case of RTV material, test was interrupted after 36 hours because of deep surface erosion that uncovers the plastic base. For the HTV sample test was finished after 53 hours, the erosion was flat and uniform along the ground electrode.

Aging resistance in the modified inclined plane test was higher for the HTV material especially for 5mm thick samples in compare to the 0,4 mm thick RTV samples.

IV. Conclusions

- Silicone rubbers can be subjected directly to modified inclined plane test without necessity of increasing their surface wettabilities.
- Leakage currents on RTV coating were in the form of single impulses while in the case of HTV material from the beginning continuous currents were recorded. This indicate on the active suppression of the current by the RTV rubber in the presence of moisture.
- For RTV coating surface discharges caused local deep erosion while for HTV materials the erosion was flat and uniform along the ground electrode.
- Aging resistance in the modified inclined plane test was higher for the HTV material especially for thicker samples.

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Time-Frequency Analysis of Distorted Electric Signals using a Complex Space-Phasor

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Abstract- **We consider applying non-parametric and parametric methods for calculation of time-frequency representation of non-stationary electric waveforms. Space-phasor is applied as a complex representation of 3-phase signals and visualization of the spectrum of positive and negative-sequence components. We compare the uncertainty of measurements using described time-frequency representations, as well as a widely used Fourier techniques. Proposed methods allow tracking instantaneous frequency as well as magnitude of non-stationary signals in power systems. Possible applications in diagnosis and power quality area are targeted.**

I. INTRODUCTION

Representation of signals in time and frequency domain has been of interest in signal processing areas for many years, especially when analyzing time-varying non-stationary signals. This kind of representation attracts nowadays more attention also in electrical power engineering.

Modern frequency power converters generate a wide spectrum of harmonics components, which can deteriorate the quality of the delivered energy, increase the energy losses and decrease the reliability of a power system

The standard method for studying time-varying signals is short-time Fourier transform (STFT) which is based on the assumption that for a short-time period the signal can be considered as stationary. The crucial drawback of this method is that the length of the window is related to the frequency resolution.

The time-frequency characterization of signals that can overcome the above-mentioned drawback became a major goal of signal processing research. Observing recent approaches to the time-frequency representations we can distinguish two main groups, namely, non-parametric and parametric methods.

Long development (for details see [1]) led to Wigner and Wigner-Ville distribution, which can be treated as a basic equation of a one wide family (Cohen's class [2]). Time-varying spectra obtained using the Wigner Distribution (WD) shows better frequency concentration and less phase dependence than Fourier spectra [4].

Considering the second group of spectrum estimation methods, namely parametric methods, which are based on the linear algebraic concepts of subspaces, leads to so-called "subspace methods". Its resolution is theoretically independent of the signal-to-noise ratio. One of the most important is the Min-Norm method [5]. In order to adapt this high-resolution method for analysis of non-stationary signals we use a similar approach as in short-time Fourier transform. The time-varying signal is broken up into minor segments with the help of the temporal window function and each segment is analyzed independently.

In the paper we present results of investigations of a converter-fed induction motor drive under transient conditions. Proposed approach includes representation of 3-phase system by complex space-phasor and its subsequent time-frequency analysis using Min-Norm method and Wigner Distribution. General purpose of the work is to emphasize the advantages and disadvantages of proposed methods in point of their application for time-varying spectral estimation in electrical power engineering.

II. SHORT OUTLINE OF APPLIED METHODS

Complex Space-Phasor

Considering a 3-phase voltage system f_R, f_S, f_T we can define complex space-phasor $f_p = f_\alpha + j \cdot f_\beta$ given by [3]:

$$\begin{bmatrix} f_\alpha \\ f_\beta \end{bmatrix} = \frac{2}{3} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} f_R \\ f_S \\ f_T \end{bmatrix} \tag{1}$$

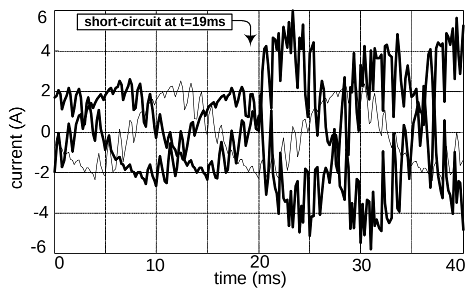

Figure 1. Three-phase current signal at the converter output during a two-phase short-circuit [1].

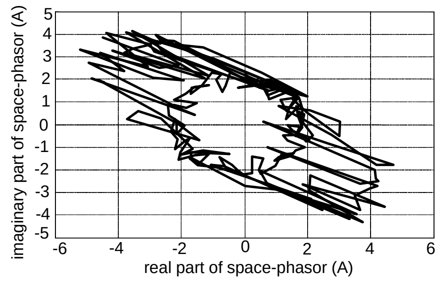

Figure 2. Trajectory of complex-space-phasor of signal from Fig. 2 [1].

Wigner Distribution

The Wigner (WD) and Wigner-Ville (WVD) distributions are the time-frequency representations given by [2]:

$$\mathrm{WD}_x(t,\omega)=\int_{-\infty}^{\infty} \mathrm{x}\left(t+\tfrac{\tau}{2}\right)\mathrm{x}^*\left(t-\tfrac{\tau}{2}\right)\mathrm{e}^{-\mathrm{j}\omega\tau}\mathrm{d}\tau,$$
$$\mathrm{WVD}_x(t,\omega)=\int_{-\infty}^{\infty} \mathrm{x}_a\left(t+\tfrac{\tau}{2}\right)\mathrm{x}_a^*\left(t-\tfrac{\tau}{2}\right)\mathrm{e}^{-\mathrm{j}\omega\tau}\mathrm{d}\tau \qquad (2)$$

where: t - time, ω - angular frequency, τ - time shift, $\mathrm{x}(t)$ - analysed real signal, $\mathrm{x}_a(t)$ analytic signal, $\mathrm{x}_a(t)=\mathrm{x}(t)+j\hat{\mathrm{x}}(t)$, with orthogonal imaginary part obtained using the Hilbert transform.

Bilinear nature of above equation (2) manifests itself in existence of undesirable components, called cross-terms (c-t). Cross-terms are located between the auto-terms and have an oscillating nature. When real signals are investigated, the undesirable cross-terms appear as interactions between components localized in negative and positive part of the frequency axis.

The sense of proposed new approach is based on the knowledge that spectrum of the space-phasor contains information about positive- and negative-sequence components simultaneously, along the positive and negative part of frequency axis, respectively. Thus, time-frequency analysis would track the changes of positive and negative sequence components simultaneously. Application of specific kernel functions leads to modified WVD distributions. This group is represented in this paper by Choi-Williams Distribution (CWD) (for details, see[1]).

Min-Norm Method

This method assumes that data can be modeled as a sum of M complex sinusoids in complex white Gaussian noise[5].

$$x[n]=\sum_{i=1}^{M} A_i \exp(j2\pi f_i n+\Phi_i)+z[n] \qquad (3)$$

for n = 0,1,...,N-1, z[n] is complex white Gaussian noise with zero mean and variance δ_0. A_i – amplitudes f_i – frequencies and Φ_i - phases.

The $N\times N$ autocorrelation matrix of the above signal for $N>M$ is defined as:

$$\mathbf{R_{xx}} = \sum_{i=1}^{M}\mathbf{P_i e_i e_i^{*T}}+\sigma_0^2\mathbf{I}=\mathbf{R}_{signal}+\mathbf{R}_{noise} \qquad (4)$$

where $\mathbf{P}_\mathrm{i}$ stands for powers of each complex sinusoid, $\mathbf{e}_\mathrm{i}$ for eigenvectors of the autocorrelation matrix and $\mathbf{I}$ for identity matrix. $\mathbf{R}_{\mathrm{xx}}$ is the sum of a signal autocorrelation matrix $\mathbf{R}_{signal}$ and a noise autocorrelation matrix $\mathbf{R}_{noise}$.

The frequency information is contained within the matrix $\mathbf{R}_{signal}$, which eigenvectors corresponding to the M largest eigenvalues contain information about signal parameters. To extract the information it is also possible to use the property of the orthogonality of eigenvectors.

Min-Norm method uses only one optimal vector $\mathbf{d}$ for frequency estimation. This vector, belonging to the noise subspace, has minimum Euclidean norm and his first element equal to one, defined as:

$$\mathbf{d}=\frac{1}{\mathbf{c}^{*T}\mathbf{c}}\mathbf{E}_{noise}\mathbf{c}=\begin{bmatrix}1\\ \left(\mathbf{E}'_{noise}\mathbf{c}\right)/\left(\mathbf{c}^{*T}\mathbf{c}\right)\end{bmatrix} \qquad (5)$$

Pseudospectrum (not a true spectrum, because it does not contain any information about the true energy of the signal) is defined with the help of $\mathbf{d}$ as:

$$\widehat{P}\left(e^{j\omega}\right)=\frac{1}{\left|\mathbf{w}^{*T}\mathbf{d}\right|^2}=\frac{1}{\mathbf{w}^{*T}\mathbf{dd}^{*T}\mathbf{w}} \qquad (6)$$

where $\mathbf{w}=\begin{bmatrix}1 & e^{j\omega_i} & \cdots & e^{j(N-1)\omega_i}\end{bmatrix}^T$.

The time varying signal is broken up into minor segments (with the help of the temporal window function) and each segment (possibly overlapping) is analyzed. Pseudospectrum (6) is estimated for each time instant. Instantaneous estimates of $\widehat{P}\left(e^{j\omega}\right)$ can be regarded as estimates of the instantaneous frequency of the signal.

III. Investigations and Discussion

In the paper we show investigation results of a 3kVA-PWM-converter drive with a modulation frequency of 1 kHz supplying a 2-pole, 1 kW asynchronous motor (supply voltage 220 V, nominal power 1,1 kW, slip 6 %, cosφ=0.81). The design the intermediate circuit includes typical L, C values for a 3 kVA converter. Fault operation of the converter drive is chosen as a short-circuit between motor leads (A and B) which occurs at the time instant of 19ms.

Time-frequency representations of the complex space-phasor were investigated using parametric Min-Norm method with a sliding temporal window function.

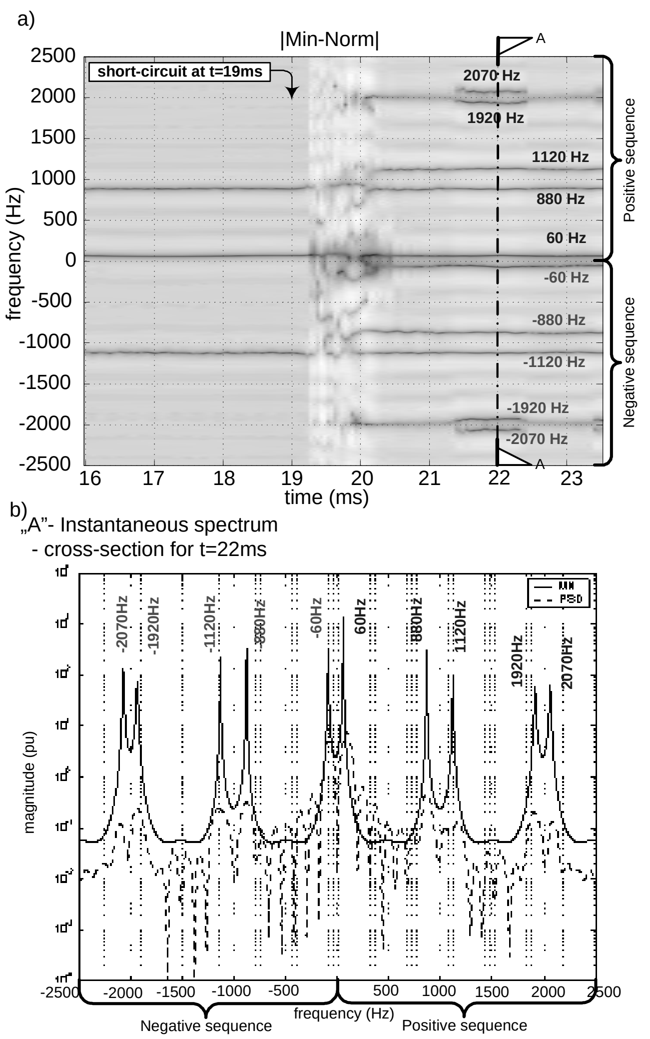

Figure 3. Time-frequency representation of the complex-space phasor from Fig. 3, obtained using Min-Nom method with sliding window (a) and its cross-section for time t=22ms (b) [1].

Instantaneous spectrum of calculated space-phasor, was shown in Fig. 3a. The Min-Norm method enabled to detect two inter-modulation frequencies (880 Hz and 1120 Hz), and two additional components (1920 Hz and 2070 Hz) after the short-circuit. Details of tracked instantaneous spectrum for particular time after the short-circuit can be observed in Fig. 3b. For comparison, the classical power spectral density (PSD) is presented. Proposed method is characterized by more accurate detection of investigated components than classical Fourier algorithm.

IV. ACCURACY OF APPLIED METHODS

The comparison of uncertainty of measurements using all described methods, as well as a widely used power spectrum estimator can be useful for practitioners, helping to choose a method which provides most accurate results under special requirements of a given measurement setup.

From the engineering point of view, in the area of interest of the author, it is more important to know what the limits of each method are and how the accuracy is affected in usual experimental setup.

In power systems, the analyzed waveforms usually consist of many harmonic components, sometimes with low-amplitude, sub- or interharmonics added [4]. Such signals are not difficult to analyze using FFT-based methods, provided that a long recording of a stationary signal is available. Such assumption is often not fulfilled, since many fault-mode or transient state records contain highly nonstationary components of relatively short duration.

The following experiment is designed to compare the uncertainty in time and frequency of parameter estimation (amplitude and frequency of each signal component). Testing signals are designed to belong to a class of waveforms often present in power systems. Several experiments with simulated stochastic signals were performed, in order to compare different performance aspects of parametric (Min-Norm) and non-parametric methods (WVD, and power spectrum - PSD).

Selected results are presented in Fig. 4. From the analysis of presented results it follows that parametric Min-Norm method shows very high accuracy in frequency estimation but relatively low in amplitude estimation (this is most likely caused by the inaccuracies in estimation of the autocorrelation matrix when its size is limited to 50) [1]. The power spectrum shows very high dependence of the error on the amplitude of higher harmonics, i.e. very high degree of masking effect of low-amplitude harmonics by main high-amplitude harmonic components, clearly visible in Fig. 4b. Well-known deficiency of FFT-based methods (sometimes called "error of synchronization") which consists of minimization of the estimation error for window lengths equal to the integer multiple of one period of the fundamental components influences the accuracy of estimation. Such dependence (which can be troublesome for sub- or interharmonic analysis) does not affect the performance of any other investigated method.

Comparing non-parametric family with Min-Norm method we can notice better accuracy of frequency estimation in case of parametric family.

On the other hand, non-parametric methods allow estimating amplitude of tracked components with better accuracy than Min-Norm technique.

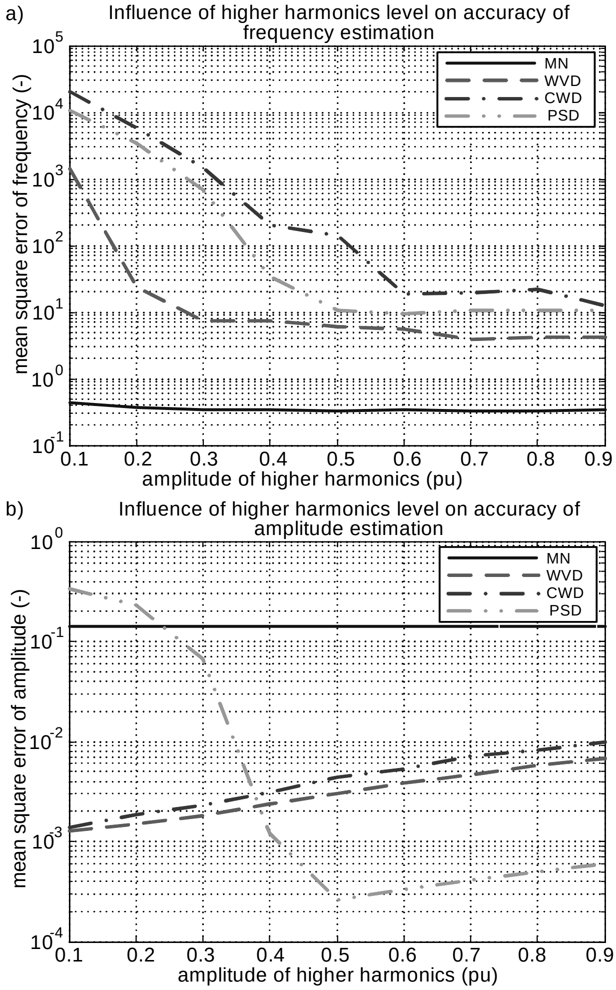

Figure 4. Influence of amplitude of higher harmonics on accuracy of frequency (a) and amplitude (b) estimation. [1].

V. CONCLUSIONS

Proposed methods can be treated as reliable detection and measurement methods of distorted waveforms in power engineering area. Additional degree of freedom which bring two-dimensional time-frequency representations allow to track distribution of frequency components over the frequency spectrum parallel with dynamics of investigated phenomena over the time.

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Hydrogen Influence on Properties of Thin Film Arresters

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***Abstract*- The influence of H_2 atmosphere on the temperature dependence of resistivity of Zn-Bi-O thin films were characterized in this study. The I-V properties of selected samples were measured by a stabilized dc power source. The resistivity of films vary considerably depending on the concentration of hydrogen.**

I. INTRODUCTION

ZnO-based varistors have been investigated since the early 1970s [1]. The microstructures of these varistors consist of semiconductive ZnO grains surrounded by a complex intergranular material, whose composition depends on the type and number of additives (Bi_2O_3, CoO, MnO, Al_2O_3) [2,3]. In the nonlinear regime, the relation between current and the applied voltage is often express in terms of power-law

$$I=f(V^{\alpha}) \qquad (1)$$

where α is the nonlinearity exponent that depends on, among other things, the microstructure of the device. This nonlinear properties was used in commercial surge arresters in high voltage application in the area of power engineering where switching voltage is in the range of kV. Another new market for surge protection are found in low-voltage application, such as in automobile electronics and semiconductor electronics. These device typically operate in the range from 3 to 12V. Consequently, it is possible to reduce varistor breakdown voltage by reducing the number of grains across which the current must flow, which in turn can be done by either reducing the thickness of the device or increasing the matrix grain size. A ideal approach for making low-voltage varistors are thin layers devices [4]. Thin film $ZnO-Bi_2O_3$ arresters as distinct from bulk varistors have low switch voltage and exhibit high nonlinear I-V characteristic [5, 6, 7]. Additionally thin layers structures behave as a model system for the grain boundary region in bulk varistors which are responsible for switching effect .

However a porous $ZnO-Bi_2O_3$ thin film exhibit high surface gas adsorption [8, 9, 10]. Concentration and type of gas components change considerably the I-V characteristics of varistors. Therefore the gas sensing properties for new type of thin film arresters are very important.

II. EXPERIMENTAL

I-V characteristics of thin film varistors were measured by scanning the DC electric fields at a speed of 0.1 do 1 $Vmin^{-1}$ until the current flowing through the specimens reached 1 mA. These measurements were carried out in the temperature range from room temperature to 60°C. At every temperature the measurement was carried out in He at first, then in a mixture of 5% H_2 balanced with helium.

III. RESULTS AND DISCUSSION

The I-V characteristics of Zn-Bi-O thin film varistors are shown in Fig.1.

All varistors tested exhibited nonlinear I-V characteristics and the magnitude of the breakdown voltage decreased with increasing H_2 concentration.

However, the relatively biggest breakdown voltage shift was observed for low concentration of hydrogen. For higher concentration of H_2 this shift decreases. A similar results for shifting of breakdown voltage was obtained both for bulk samples and another varistor composition e.g. SnO_2-based varistor [10]. There are general trend showing that the breakdown voltage (U_z) shifts to a high electric field in air or oxidizing atmospheres (NO_2, O_3) and to the low electric field upon exposure to H_2 or reducing atmospheres, and the magnitude of the shift is well correlated with gas concentration [11].

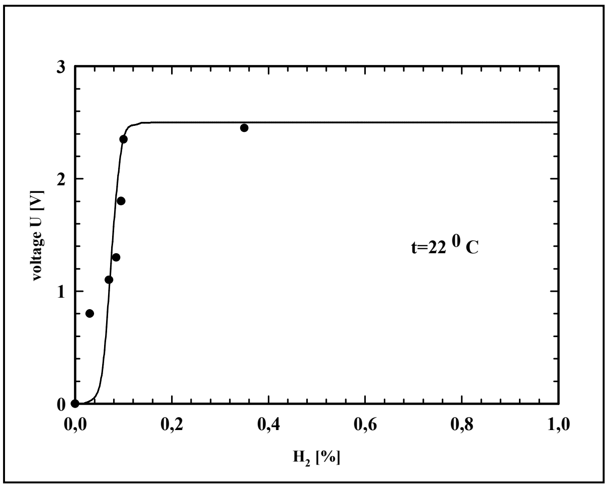

Figure 1. The breakdown voltage for thin film varistor upon exposure to different H_2 concentration at room temperature.

Explanation of gas-sensing mechanism of ZnO-based varistor is connected with chemisorption of negatively charged species in oxidizing atmospheres which determine the high of the Schottky barrier at grain boundaries or necks, thereby resulting in a shift of the breakdown voltage to a high electric field. Hydrogen chemisorption change the potential barrier height induced by the consumption of oxygen adsorbates leading to a lower surface coverage of negatively charged species.

A rise in the temperature intensify the chemisorption phenomena which is related with. A increase in working varistor temperature from room temperature to 60°C result in a decrease in the breakdown voltage, as shown in Fig.2.

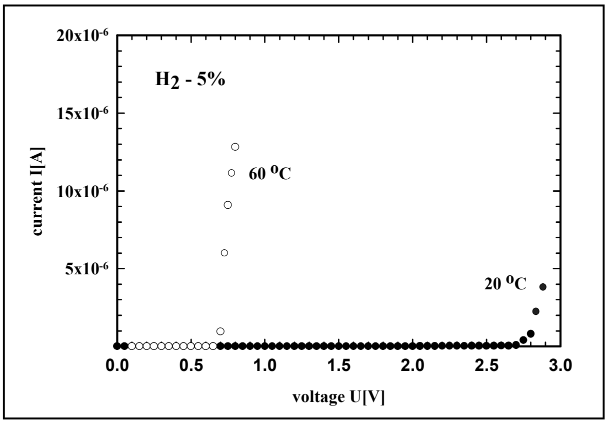

Figure 2. . I-V characteristics of thin film varistor in a H_2 atmosphere at room temperature and 60 °C.

IV. CONCLUSIONS

It is confirmed that a semi-amorphous Zn-Bi-O thin films could be prepared by magnetron sputtering which exhibit non-linear I-V varistor characteristics in air and as well as in H_2 sensitivity in the temperature range 25-60°C

The breakdown-voltage shift to low electric field upon exposure to H_2 is observed. Thus, the Zn-Bi-O thin films could also work as a varistor-type H_2 sensor.

The breakdown-voltage decreased with increasing varistor working temperature for constant H_2 concentration.

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Influence of Sheds Inclination of Non-Ceramic Insulators on Develop of Leakage Current in the Rain and Fog Conditions

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***Abstract*- The paper presents results of laboratory tests of HTV silicon rubber insulators with different inclination of upper surface of the sheds (10º, 30º) in the rain and fog chamber. The main stresses were AC (50 Hz) high voltage in presents of periodical rain or fog. During the tests leakage current was recorded. After the tests surface hydrophobicity was evaluated. The goal of test of silicone rubber insulators in fog and rain chambers is to obtain of experimental dates which show influence of their sheds inclination on develop of leakage current in rain and fog conditions.**

I. INTRODUCTION

Silicone rubber insulators offer a lot of advantages over ceramic such as light-weight construction, ease of installation and maintenance, vandalism resistance, improved contamination performance due to use hydrophobic materials and compact line design. The most valuable feature of these insulators is hydrophobic property [1,2]. This property is responsible for the low wettability that reduces develops of leakage current and surface discharges and makes it necessary to minimize the effect of their relatively low ageing resistance. Additional in presents of pollution silicone rubber allow transferring of low molecular fraction (LMW) from the bulk to its surface.

As regards ceramic insulators, researchers have paid much attention to shape optimisation and the gained experience is now applied in the design of composite insulators. But the transfer of experience relating to the shape of ceramic insulators directly onto composite insulators does not allow one to fully exploit the advantages of polymer materials, especially their low surface energy.

Present of water in the form of rain or fog causes silicon rubber insulators to nonuniformly lose their hydrophobic properties as a result of the washing out of low molecular fractions from the surface of the silicon rubber [3] and corona discharges from water droplets [3,4]. The consequence of the nonuniform loss of hydrophobic properties by insulator surfaces and the formation of intershed water bridges [5,6] are highly nonuniform distributions of voltage and electric field intensity. They may cause the initiation and development of surface discharges having a highly corrosive effect on the silicon housing materials [7], which may lead to serious damage to the insulators.

The shape of the composite insulator and the design parameters of its sheds play a significant role in this mechanism of ageing which on the whole is similar in rain and fog conditions.

II. SUBJECT OF INVESTIGATION AND TESTS SETUP

Model composite insulators with their housings made of silicon rubber, destined for 24 kV rated voltage were investigated. The insulators had a very similar dry arcing distance (275-295 mm) and a leakage current distance (645-660 mm), as required by the basic criteria classifying composite insulators from the electrical point of view, specified in IEC 61466-2. They differ in their inclination of upper surface of the sheds. The same housing material – high-temperature vulcanised silicone rubber (HTV) – was used to manufacture the model insulators. Figure 1 shows a picture of tested insulators.

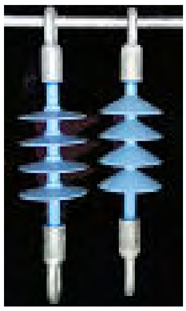


Figure 1. The tests subjects – 4 sheds HTV insulators.

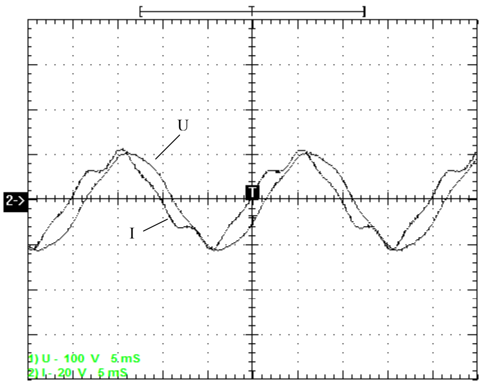
The tests were carried out in high voltage fog and rain chambers. The fog chamber was equipped with a standardized system of nozzles located in opposite corners. The fog generating unit includes an oil compressor and a water pump. The system operates in a closed cycle and is controlled by a time programmer. The sprinkling system operates in a similar way. The water's conductivity was 200 mS/cm.

The test plan provided for 7 hours of ageing with each hour comprising a 30 minute (fog or rain) sprinkling cycle and a 30 minute period with no fog or rain generation. After ageing the insulators 'rested' for 17 hours. The insulators were aged at a voltage of 40 kV.

To the leakage current registration was used a PC computer and a METEX multimeter. The rain chamber was equipped in different sprinklers, the system was without a compressor and a programmer controlled only the pumps. The water's conductivitiy in tests in the rain chamber was on the same level as in case the fog chamber.

III. Test Results

The most important parameter was recorded leakage current which also indicate indirectly level of surface hydrophobicity. Gradually loss of hydrophobic properties caused increase of leakage current level. Comparison of recorded current shapes allows pointing at the better insulator sheds inclination. Problem of silicone rubber insulator shape optimization was presented in [8].



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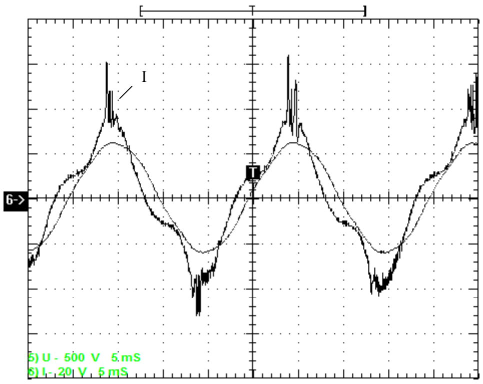
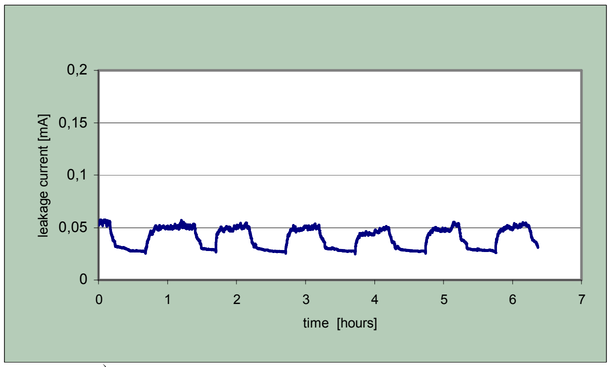


b)

Figure 2. Leakage current oscillograms registered after 24 days of ageing in the rain chamber,

a) insulator with sheds inclined at 30°,
b) insulator with sheds inclined at 10°.

Figure 2 shows oscillograms made after 24 days of ageing in the rain chamber. In the case of the insulator with a shed inclination of 30° the leakage current has still a capacitive character (Fig. 2a) whereas in case of the insulator with a shed inclination of 10° current has a resistance character (Fig. 2b). The leakage current is clearly higher for the insulator with its sheds inclined at an angle of 10°. The discharges, having the form of blue threads, develop on the undersides of the sheds, especially on the underside of the first shed on the high voltage side.



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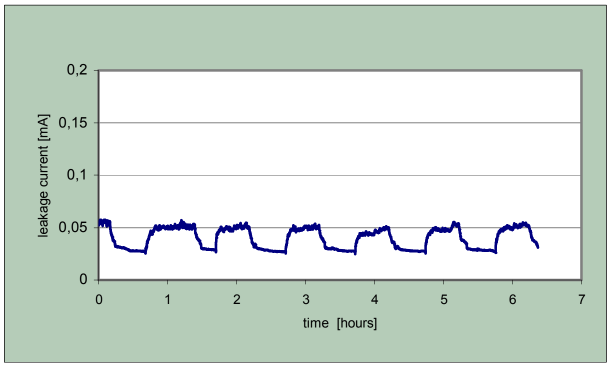


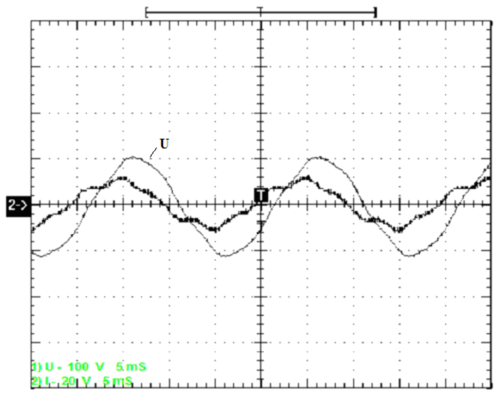
b)

Figure 3 Leakage current versus aging time on 28th day of ageing in the rain chamber,

a) insulator with sheds inclined at 30°,
b) insulator with sheds inclined at 10°.

Figure 3 shows diagrams of leakage current versus aging time. The highest value of current was registered for insulator with a shed inclination of 10° and was exceed 0,15 mA whereas for 30° insulator was on the level 0,05 mA.

Figure 4 presents oscillograms made after 25 days of ageing in the fag chamber.



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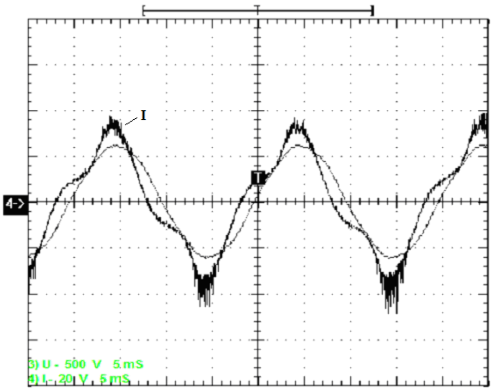


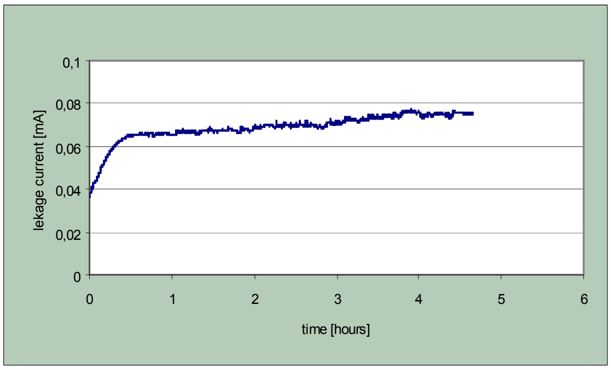
b)

Figure 4. Leakage current oscillograms registered after 25 days of ageing in the fog chamber:

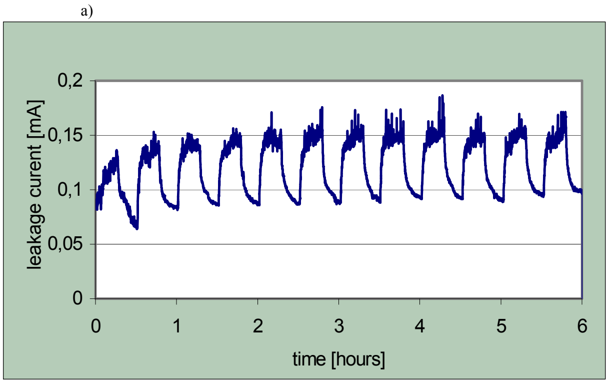
a) insulator with sheds inclined at 30°,

b) insulator with sheds inclined at 10°.

The results are similar to results obtained in the rain chamber. In the case of the insulator with a shed inclination of 10° shape of current curve indicate on surface discharges occurrence. Current amplitude is also much higher than in case of insulator with a shed inclination of 30°.



a)



b)

Figure 5 . Leakage current versus aging time on 28th day of ageing in the fog chamber:,

a) insulator with sheds inclined at 30°,

b) insulator with sheds inclined at 10°.

Leakage currents recorded in the fog chamber are showed on Figure 5. In this case insulator with a shed inclination of 30° turned out again better than insulator with a smaller inclination of the sheds. The highest value of leakage current did not exceed 0,08 mA and shape of the current curve was almost flat (Fig. 5a) whereas for the insulator with almost flat sheds this value was equal 0,18 mA.

IV. CONCLUSIONS

Angle of sheds inclination is important construction parameter of high voltage silicone rubber insulator. Steep inclination upper surface of insulator sheds reduce process of losing hydrophobicity and develop of leakage currents which leads to surface discharges in rain and fog conditions. Thus in outdoor application of insulators with steep sheds inclination can have better aging resistance.

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Aspects of Fast Fourier Transform Application for Analysis of Electrical Systems with Wind Generation

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***Abstract*-One of the most powerful tools in spectral analysis is the Fast Fourier Transform (FFT). Since the sixties it has been successfully installed in many electrical engineering applications. Nowadays, the engineer needs to press a button to get results. Nevertheless, meaningful analysis of measurements requires in-depth knowledge of the FFT algorithms. Sometimes the engineer would be forced to use other spectral analysis tools, e.g. Prony method to obtain satisfactory results. The paper is concerned with educational aspects of FFT. The engineer in spe should be aware of the features and restrictions imposed on FFT and if needed refer to other spectral analysis methods.**

I. INTRODUCTION

Spectral analysis of current and voltage signals is a common practice in electrical engineering. Protection algorithms, control of electrical drives and power quality assessment routines require the information of spectral components[1],[2],[3].

Fast Fourier Transform [4] is very popular and broadly applied as a build-in algorithm in many devices, which does not require specific knowledge from the user. Power quality analyzers may be seen as an example [5]. The technician operating such a power analyzer gets a plot of spectral components instantly after pressing a button. It seems to be a easy and reliable procedure.

Nevertheless, the proliferation of wind farms and other nonlinear devices into the electrical system results in sophisticated current and voltage signals which should be analyzed with special care. Transients and interharmonics are present in current signals measured in systems with wind farms. Power quality analysis in such systems should be done accordingly, with special respect to restriction inherent in FFT method. Otherwise results may be wrong and led to equipment malfunction or damage.

Electrical Engineers *in spe* should be equipped with mathematical foundations and in-depth knowledge about properties and features of DFT. Analysis results need to be assessed by them rightly and in case other methods put in place.

This paper points out some important aspects of FFT teaching. Consequently, application of FFT and an alternative method (Prony model) for analysis of signals in wind generator is shown as an informative practical case.

II. FOURIER TRANSFORM FOUNDATIONS

Mathematical foundations are briefly presented below.

A. *Fourier Transform*

A function x defined in time domain can be expressed by its Fourier transform $Y(f)$ in frequency domain [6].

$$Y(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi f} dt \tag{1}$$

Introducing FT mathematical basics, some important properties needs to be mentioned: linearity, changing time scale inversely affecting frequency and amplitude, shifting the function changing the phase of the spectrum, symmetries in time domain and their implications also convolution theorem.

Additionally, expansion in Fourier series needs a careful introduction. Several explanatory exercises are advisable.

B. *Discrete Fourier Transform*

The Fourier Transform [7] of discrete series $x[n]$ is defined

$$Y\left(e^{j\omega}\right) = \sum_{n=-\infty}^{n=\infty} x[n] e^{-j\omega n} \tag{2}$$

Generally, $Y(e^{j\omega})$ is a complex function and may be given as

$$\mathrm{Y}\left(\mathrm{e}^{\mathrm{j}\omega}\right) = Y_{re}\left(\mathrm{e}^{\mathrm{j}\omega}\right) + Y_{im}\left(\mathrm{e}^{\mathrm{j}\omega}\right) \tag{3}$$

Equation (3) may be rewritten (4) and used to compute the magnitude (5) and phase spectrum of the signal (6).

$$Y\left(\mathrm{e}^{\mathrm{j}\omega}\right) = \left|Y\left(\mathrm{e}^{\mathrm{j}\omega}\right)\right| e^{j\theta(\omega)} \tag{4}$$

$$Y_M = \left|Y\left(\mathrm{e}^{\mathrm{j}\omega}\right)\right| \tag{5}$$

$$\theta(\omega) = \arg\left\{Y\left(e^{j\omega}\right)\right\} \tag{6}$$

Both equations (5) and (6) are odd and even functions of real variable ω respectively.

It is advisable, to introduce the similarities between the Fourier Transform and the Z transform

$$Y\left(e^{j\omega}\right) = X(z)\Big|_{z=e^{j\omega}} \tag{7}$$

For finite series x[n] o<n<N-1 the corresponding Fourier Transform may be obtained by sampling the continuous Transform

$$Y[k] Y\left(\mathrm{e}^{\mathrm{j}\omega}\right)\Big|_{\omega=2\pi k/N} = \sum_{n=0}^{N-1} x[n] e^{-j2\pi kn/N} \tag{8}$$

The inverse Fourier Transform is given by

$$x[n] = \frac{1}{N}\sum_{k=0}^{N-1} Y[k] e^{-j2\pi kn/N} \tag{9}$$

III. Numerical Realization

The practical realization of spectral analysis of periodical signals is effectively introduced using the Matlab [8] environment. The students should verify the influence of diverse parameters on the transformation accuracy.

Simple and understandable Matlab code

```
t=0:1/100:10-1/100;
x=sin(2*pi*40*t);
y=fft(x);
```

gives the opportunity for explaining periodic sampling, aliasing, signal ambiguity in frequency domain and Nyqiust frequency. Fig. 1 shows the spectrum of the above sinusoidal signal where the 60 Hz component should be properly interpreted.

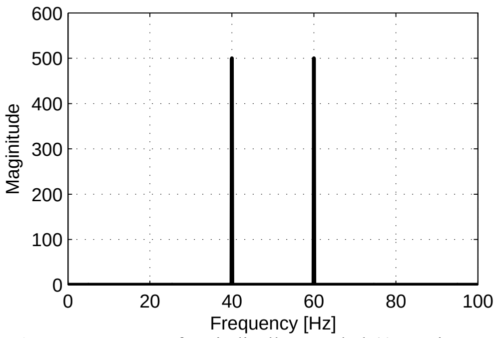

Figure 1. FFT spectrum of periodically sampled 40 Hz sinus waveform with Nyquist frequency of 50 Hz

Consequently, further characteristic features need introducing: DFT symmetry, linearity, shifting theorem, leakage, frequency resolution, windowing, and other. The frequency and phase spectra should be observed. The resolution problem should be treated with special care.

Sampling of Low-Pass and Band-Pass signals and digital filtering bring important skills in practical implementation of Fourier Transform. In the final step the spectral analysis should be done using a DSP (digital signal processor).

Another question is the selection of signals for analysis. In the initial stage, simple simulated signals are useful. Starting with simple sinusoid the features of FFT can be explained and other spectral components added to the signal in a controlled manner. The noise can also be mixed by step for step. One important educational aspect is the resolution quality of nearby components, e.g. components not fare from the main 50 Hz.

Praxis relevant signals should be processed with regard to opwer quality issues [9] as soon as the basics are introduced and understood.

IV. Analysis of Signals form Wind Generator

Closing of compensating capacitors is a common practice in wind generation units [10]. The measured signal (Fig. 1) has a decaying component which can not be analyzed adequately with FFT. The transient component initial amplitude was correctly computed with Prony method (Fig. 2). Those types of signals are helpful in showing the restriction of FFT and simultaneously signalizing other useful methods of signal processing.

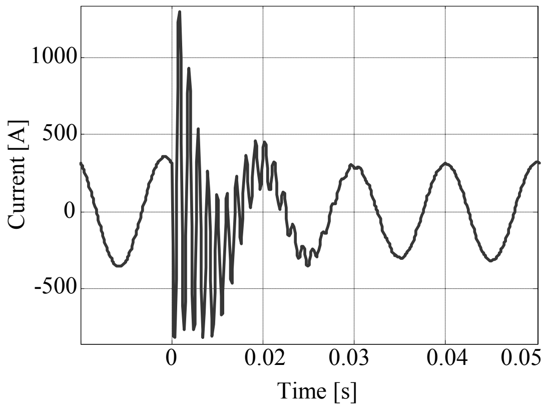

Figure 2. Current signal after capacitor bank closing

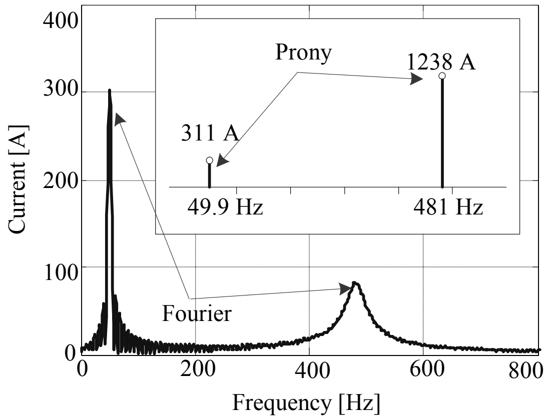

Figure 3. Spectral analysis of current occurring after capacitor switching

V. Conclusion

In this paper the basics features of Fourier Transform are shown with relevance to educational aspects. The importance of proper presentation of restrictions inherent in the algorithm is stressed and accompanied by analysis of practice relevant signal from wind generator.

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Distribution System Reliability Evaluation Incorporating the Effect of Voltage Stability Index

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***Abstract*—A distribution system is the system of an overall power system which links the bulk system to the individual customers. Reliability and Quality of supply(Voltage Stability) are important performance indices of a distribution system which need to be satisfied from customer point of view. This paper deals with calculation of both Reliability indices and Voltage Stability Index for a typical distribution system to analyze the optimum configuration.**

***Index Terms*— Distribution System, reliability, quality, voltage stability.**

I. Introduction

The proliferation of equipment and the basic structure results in a relatively high proportion of customer outages being associated with the distribution system[1].Data on utility failure statistics show that distribution system failures are approximately 80 percent of the total customer interruptions[2].Thus from the customers' point of view the reliability of distribution systems is at least as important as the reliability of generation and transmission.

Voltage stability is another important performance index which defines the quality of supply. Voltage in a transformer is expected to be constant from the customer point of view. In most of the analysis [3,4] either voltage stability or reliability along with minimized cost has been considered as the basis of distribution system planning.

A typical radial distribution system is considered and both reliability and VSI are calculated and assessed. The network is reconfigured and the new values of performance indices are calculated. Thus we have considered the distribution system reliability incorporating the effect of voltage stability index which gives a better insight to the requirement from the customers'.

II. Distribution System Performance Indices

Distribution networks are the parts of power systems that deliver energy from the area supply stations to the customers. They operate at several voltage levels (mostly from 11 kV to 33 kV in India), and often include the networks of local or municipal utilities[5].

A. Reliability Indices

1) Time Frequency Duration Indices

Failure frequency index $(f_F) = \sum C_{mn} \; f_{Fmn} / \sum C_{mn}$

Where the load point frequencies are weighed by C_{mn} , the number of customers on branch mn.

Mean system failure duration $(T_F) =$

$$\sum C_{mn} f_{Fmn} T_{Fmn} / \sum C_{mn} f_{Fmn}$$

Average total interruption time /customer / year $(H_F) =$

$$\sum C_{mn} f_{Fmn} T_{Fmn} / \sum C_{mn}$$

From the equation it is evident that

$$H_F = T_f f_f$$

It should be observed that the above indices are not based on any definition of what events constitute system failure, but are computed by arbitrarily chosen equations. The frequency f_{Fmn} for example is not the frequency of any given event but is an arbitrary measure of the system's performance[5].

2) Customer Load Point Indices

System Average Interruption Frequency Index (SAIFI) is the average number of interruptions of supply in the year for the customers who experience interruption of supply. SAIFI can be calculated mathematically as

SAIFI = Total no of customer interruptions/ Total no of customers served

$$= \sum \lambda_{Ni} \, Ni / \sum N_T$$

Where N_i is the number of customers in section or load point i, N_T represents the total number of customers on feeder λ_{Ni}.

System Average Interruption Duration Index(SAIDI) is the average total duration of interruptions of supply per annum that a customer experiences, for example

SAIDI=Total customer interruption duration/ Total no of customers served

$$= \sum Ui \, Ni / \sum Ni$$

U_i represents failure rate and down time of load point i.

Customer Average Interruption Duration Index(CAIDI) is the average duration of an interruption of supply in the year for customers who experience interruption of supply.

CAIDI= Total customer interruption duration/ Total no of customers interrupted

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$=\sum U_i\, N_i / \sum \lambda N_i\, N_i$

Where U_i is the outage time of the i^{th} load per year, Ni is the sum of customers at the i^{th} load point, and λ_i is the failure rate..

ASAI(Average Service Availability Index) = Customer hours of service demanded/ Customer hours of service available.[6]

B. VOLTAGE STABILITY INDEX

The voltage stability has been defined as the ability of a system to maintain voltage at all parts of the system so that with the increase of load ,both power and voltage are controllable[7].

The formula used for calculation of VSI is[7]:

$VSI = 4[\,(X_{eq}P_{leq} - R_{eq}Q_{leq})^2 + X_{eq}Q_{eq} + R_{eq}P_{leq}]$

Where,

$R_{eq} = \Sigma P_{loss} / \{(P_{leq} + \Sigma P_{loss})^2 + (Q_{leq} + \Sigma Q_{loss})^2\}$

$X_{eq} = \Sigma Q_{loss} / \{(P_{leq} + \Sigma P_{loss})^2 + (Q_{leq} + \Sigma Q_{loss})^2\}$

Where P_{leq} and Q_{leq} ae the total real and reactive loads.

III. CASE STUDY & RESULTS

A university campus is a typical distribution system with varying loads at different periods of a day. The distribution system of Birla Institute of Technology, Mesra comprises of 11 kV in coming feeders. The 11 kV/440 V transformers are situated at various sites.

The main problem encountered in BIT campus is the variation of loads at different transformers during various hours of the day. The main concentration of load during the morning hour is at the Institute building where large power is needed to supply the load demands of various classes, laboratories, library, offices etc . During this period the demand from various hostels is quiet low.

During the evening hours the maximum demand of power is from the quarters of the staff and hostels. A continuous supply should be there to cater to the demands of power for lighting the bulbs and tube lights, computers, fans. The use of some equipment, like heater, which consumes a lot of reactive power thereby causing a considerable drop in the supply voltage. So in order to ensure a consistent supply of voltage with considerable reliability we have to calculate the reliability indices and voltage stability index for various buses. The values of these indices for various feeders are calculated. Reconfiguration of the loads of the transformers is done in order to obtain an optimum configuration with better reliability indices and voltage stability index.

The line diagram of the full system is shown in Fig. 1.

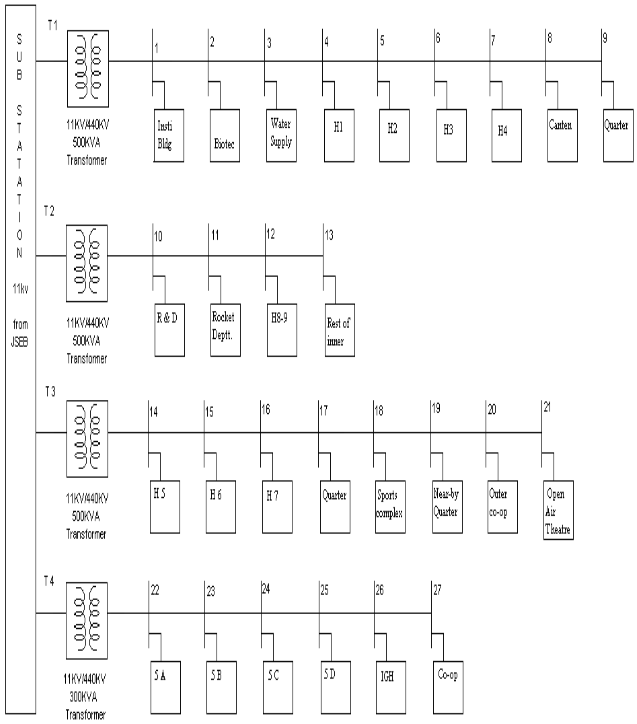

Fig. 1. Single line diagram showing the distribution system of the campus.

The transformer 1 of 500 kVA capacity supplies the loads as mentioned in Table-I.

TABLE I
TRANSFORMER I-500KVA

Description	Maximum connected load		
	KW	KVAR	KVA
Institute Building	646.29	484.7	807.86
Biotech Building	243.30	182.6	304.20
Water supply	146.51	90.73	172.33
Hostel 1,2,3,4	275	195	337.12
Canteen	100	75	125
Quarters(1&3)	69.9	118.73	137.8
Total	1481	1146.76	1872

The transformer 2 of 500 KVA capacity supplies the loads as mentioned in Table-II.

TABLE II
TRANSFORMER 2-500KVA

Description	Maximum connected load		
	KW	KVAR	KVA
R&D Building	300	249.2	390
Rocketry Dept.	200	150	250
Hostel 8&9	163.7	265	311.5
Inner Quarters	504	334.22	604.75
Total	1305.5	1069.1	1687

The transformer 3 of 500 KVA capacity supplies the loads as mentioned in Table-III.

TABLE III
TRANSFORMER 3-500KVA

Description	Maximum connected load		
	KW	KVAR	KVA
Hostel 5,6,7	451.52	277.14	529.52
Outer Quarter	483.5	362.622	604.4
Sports Complex	17	13.16	21.15
Outer canteen	10	7.5	12.5
OAT	75	66.14	100
Total	1036.62	726.28	1265

The transformer 4 of 300 KVA capacity supplies the loads as mentioned in Table-IV.

TABLE IV
TRANSFORMER 4-300KVA

Description	Maximum connected load		
	KW	KVAR	KVA
Hostel 5A	146.51	90.65	172.33
Hostel 5B	146.51	90.65	172.33
Hostel 5C	146.51	90.65	172.33
Hostel 5D	146.51	90.65	172.33
IGH+Dispensry	100	61.97	117.65
Total	686.04	425	806.97

An alternate modification of the above distribution system is shown in Fig. 2. We carry out the same analysis for the modified system.

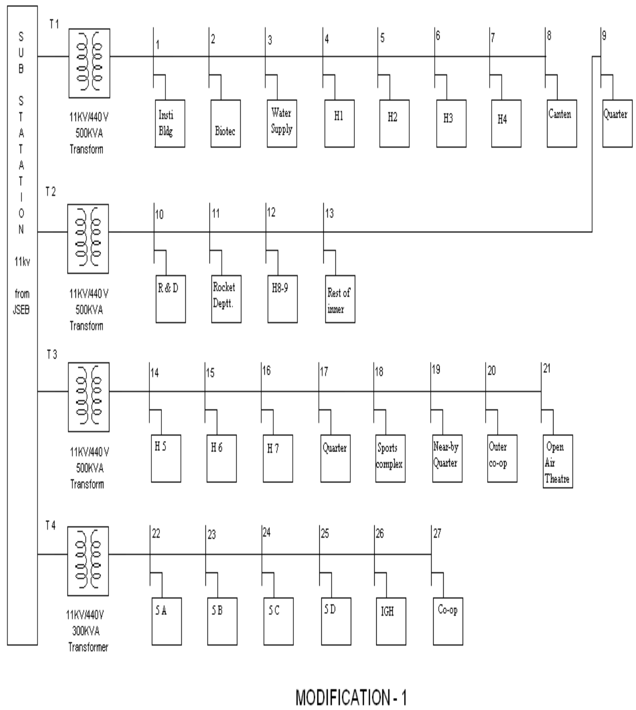

Fig 2. Modification of the distribution system

The new value of loads at various transformers are tabulated below:

TABLE V
NEW LOADS

Transformers	Calculated Data		
	KW	KVAR	KVA
G1(500 KVA)	1387	1086.76	1762
G2(500 KVA)	1399.5	1129.14	1798
G3(500 KVA)	1036.62	726.28	1265
G4(500 KVA)	686.04	425	807

By using the formulae defined above we calculate the values of reliability indices and voltage stability index for original and modified configurations both. Table-VI shows the VSI for both original and modified configuration.

TABLE VI
VSI

Transformer	VSI	
	Original	Modified-I
G1(500 KVA)	0.0021	0.00223
G2(500 KVA)	0.002345	0.0022
G3(500 KVA)	0.00307	0.00307
G4(500 KVA)	0.004	0.004
Overall system	0.002664	0.002685

Table VII compares the various reliability indices of both modified and original systems.

TABLE VII
RELIABILITY INDICES

Systems	Reliability Indices						
	F_F	T_f	H_f	SAIFI	SAIDI	CAIDI	ASAI
Original	0.174	5.308	0.922	0.174	4.99	28.75	0.9994
Modified	0.177	5.322	0.941	0.177	4.99	28.06	0.9994

From the above tables we can see that as the load on G1 decreases its VSI increases and that of G2 decreases. The VSI of the overall system is improved slightly and reliability indices decreases slightly.

The numerical values of the reliability indices and the voltage stability index (VSI) for the existing and modified or reconfigured systems show that there is a scope of improvement of the voltage stability i.e. the quality of supply but at the cost of reliability of the system.

IV. CONCLUSION

Optimal configuration of the distribution system can be obtained with acceptable values for both the indices. The compromise between quality and reliability has to be considered so that a stable and acceptable system is obtained. The optimization can be achieved by using various optimization techniques such as Genetic Algorithm, Tabu Search etc.

Thus the distribution system can be optimized for enhanced performance indices of which reliability and voltage stability are of prime concern.

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Instantaneous Frequency Calculation Using Wigner Distribution

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***Abstract*-This paper introduces two-dimensional methods of observation and diagnosis of non-stationary signals in electrical engineering as well as its further application in instantaneous frequency calculation. The investigations are carried out on two levels: firstly, two-dimensional representations are obtained applying Wigner Distribution, then local frequency moments are calculated to achieve one-dimensional characteristics of instantaneous frequency. It is shown that such characteristic preserves information about the nonstationarity in time domain and can be used for detection and duration of transient states.**

I. INTRODUCTION

Representation of signals in time and frequency domain has been of interest in signal processing areas for many years, especially taking in the limelight time-varying non-stationary signals. The standard method for study time-varying signals is short-time Fourier transform (STFT). The spectrogram utilizes a short-time window whose length is chosen so that over the length of the window signal is stationary. Then, the Fourier transform of this windowed signal is calculated to obtain the energy distribution along the frequency direction at the time corresponding to the centre of the window. The crucial drawback of this method is that the length of the window is related to the frequency resolution. Increasing the window length leads to improving frequency resolution but it means that the nonstationarities occurring during this interval will be smeared in time and frequency [5],[6]. This inherent relationship between time and frequency resolution becomes more important when one is dealing with signals whose frequency content is changing rapidly. A time-frequency characterization of signals that would overcome above drawback became a major goal for signal processing areas [1],[2],[3],[4]. One of the mathematical proposition that represents above goal is Wigner Distribution (WD).

Observation of the signal in joint time-frequency planes is especially dedicated to signals which parameters change in time. One of the prominent example can be investigation of signal with frequency modulation. This work is aimed at application of time-frequency analysis in point of tracking the parameter which is called instantaneous frequency. In order to do this some definition of local frequency moments of the Wigner Distribution are introduced which stay in connection with characteristic of instantaneous frequency [1],[4]. Delivered derivation is supported by simulations concentrated on detection and duration of transient states.

II. MATHEMATICAL BACKGROUND

The concept of the Wigner distribution could be consider as Fourier transform of instantaneous autocorrelation function [1]:

$$\mathrm{WD}_x(t,\omega)=\int_{-\infty}^{+\infty}\mathrm{x}\left(t+\frac{\tau}{2}\right)\mathrm{x}^*\left(t-\frac{\tau}{2}\right)\mathrm{e}^{-\mathrm{j}\omega\tau}\mathrm{d}\tau \qquad (1)$$

Local frequency moments of Wigner Distribution are determined by considering WD as a function of frequency for fixed time. Normalized first local frequency moment is than given by [1]:

$$\overline{\Omega^1_{WD_x}}(t)=\frac{\int_{-\infty}^{+\infty}\omega\mathrm{WD}_\mathrm{x}(t;\omega)\mathrm{d}\omega}{\int_{-\infty}^{+\infty}\mathrm{WD}_\mathrm{x}(t;\omega)\mathrm{d}\omega} \qquad (2)$$

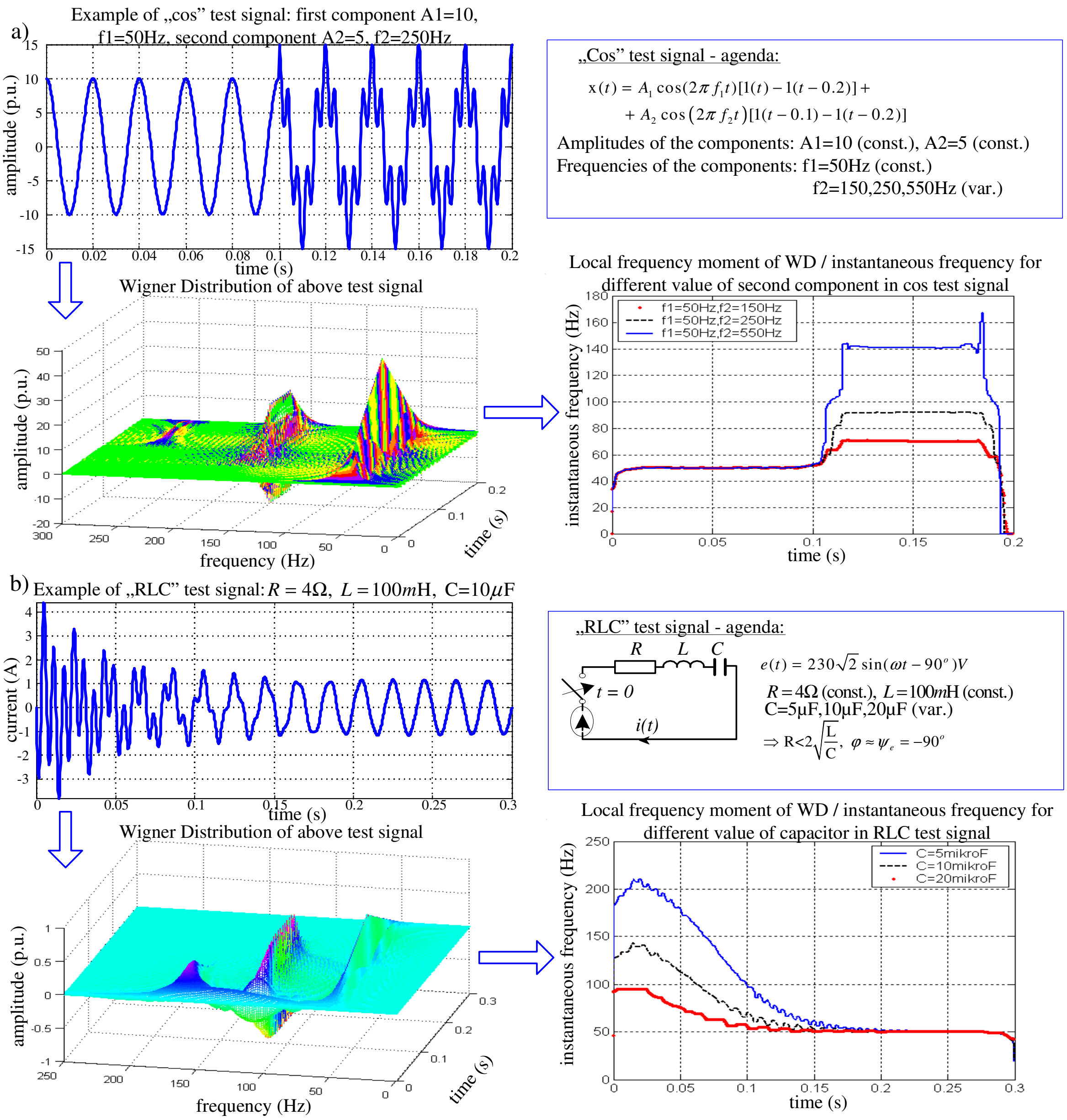
For complex signal $\mathrm{x}(t)=|\mathrm{x}(t)|\mathrm{e}^{\mathrm{j}\psi(t)}$ above equation is associated with instantaneous frequency *f*(t) defined as derivative of the phase [1],[4],[6]:

$$f(t)=\frac{1}{2\pi}\frac{d\varphi(t)}{dt}=\frac{1}{2\pi}\overline{\Omega^1_{WD_x}}(t) \qquad (3)$$

Thus, calculation of normalized first local frequency moment of WD can be then interpreted as a function which describes position of central point of the instantaneous spectrum for fixed time. It is worth emphasizing that following this interpretation, information about the frequency structure is lost, however information about the transient events is still preserved.

III. SIMULATION AND CALCULATION

The character of Wigner distribution and its normalized local frequency moments has been tested for two simulated signals: sum of two cosine functions and transient signal in RLC branch. To avoid influences in instantaneous frequency characteristic median filter was additionally applied. When small order of the filter is used no influence on dynamic of curve is achieved. Observing Fig. 1a we can detect presence of higher component when the direction of the curve is moved forward higher frequencies region. Fig. 1b depicts shifting the position of central point of the instantaneous spectrum forwards input components as a results of decaying transient component. The duration time of the transient state can be also clearly characterized, however detailed information about the frequency or amplitude of the components is hidden.



Rys. 1. Particular steps of calculation of instantaneous frequency for "cos" (a) and "RLC" (b) test signals when Wigner Distribution is proposed

IV. SUMMARY

This paper is aimed at complex analysis of transient states using time-frequency analysis and its further application. Proposed alternative approach to classical spectrogram is the Wigner Distribution. Except obtained time-frequency view of investigated nonstationarity, we can recalculated obtained representation in order to achieve some additional parameters. Presented example concerns calculation of instantaneous frequency. It has been shown that normalized first order local frequency moment of Wigner Distribution leads to instantaneous frequency, which illustrates how the centre point of spectrum change in time. This characteristic can be applied in detection and duration time of transient state.

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Parameter estimation of non-stationary signal based on the genetic algorithm

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Abstract- **Proposed method combines numerical differentiation and genetic algorithm. Fast computation of accurate results is done using only simple numerical operations, what may be regarded as a considerable advantage. Proposed method computes signal parameters effectively, even for very high noise levels. Proposed method is numerically stabile, because it utilizes multiplication, addition and generation of random numbers.**

I. Introduction

The real non-stationary signals make the analysis difficult.

In order to estimate the parameters, the method of solving sets of differential equations and genetic algorithm has been used. Genetic algorithms belong to a wide class of optimization methods, which imitate processes taking place in nature. They are numerical procedures that utilize random choices in a highly directed search of the optimal solution. The proposed method is durable and effective.

II. Genetic Algorithm

Biological concepts are utilized in the genetic algorithm. The population members, the chromosomes, represent potential solutions to a problem. The chromosomes are represented as binary sequences. Individual elements of the chromosomes are referred to as genes.

The process of the result evolution corresponds to a search in the selected solution space. Such a search requires a compromise between two objectives. On one hand, the potential solution space should be searched thoroughly. On the other hand, it makes sense to utilize already obtained solutions.

Genetic algorithm provide a reasonable compromise between the wide search of the solution space and the use of earlier obtained results. The algorithms relay on multidirectional exploration of the solution space through a transformation of the potential solution population. In each consecutive population, only the best fitted members, e.g. sufficiently acceptable solutions, are reproduced while the remaining members are eliminated from the further transformations. A target function is used as a criterion for evaluation of the population members. In each consecutive population, there are always chromosomes, which satisfy better the evaluation criterion than others.

Implementation of genetic algorithms for identification of the function parameters does not introduce any limitations on the function form or the number of estimated parameters

As a fitness function the best approximation of analyzed curve is used. That approximation is obtained after solving the set of differential equations. Runge-Kutta integration method is used due to its numerical simplicity. The genetic algorithm seeks adequate coefficients of the differential equation.

Those coefficients were properly coded and processed with the genetic algorithm. In order to estimate the parameters for the measurement signal the minimum of the approximation error has been selected as the adaptation criterion

The implementation of the GA method begins with the construction of the initial population representing the first approximation of the solution. Genes of this generation are selected randomly. Usually, this first approximation is not a good solution.

For the fitness function is used to evaluate each member of the population. To each member, a value calculated from the adaptation function is assigned. New members are reproduced in successive generations. The reproduction is usually consistent with rules of roulette. A segment of the roulette wheel corresponds to each member of the population. The size of the segment is proportional to the value of the evaluation function. Members with the larger segments of the roulette wheel have better chances to create a new generation [1]. For each randomly selected member, an exact replica (offspring) is formed and after genetic operation is included in the next generation. One may note that for members with high value of the adaptation function, there is much higher probability of having several identical descendants than in the case of members with a small value of the adaptation function.

Application of the genetic operators constitutes the next step of genetic algorithms. Members of the new generation undergo modifications through the crossovers and mutations. Crossover leads to a combination of the parental traits in chromosomes of two descendants. Genotype fragments are exchanged between the two members. With an initially assumed crossover probability, both a pair of members and the crossover points are selected randomly.

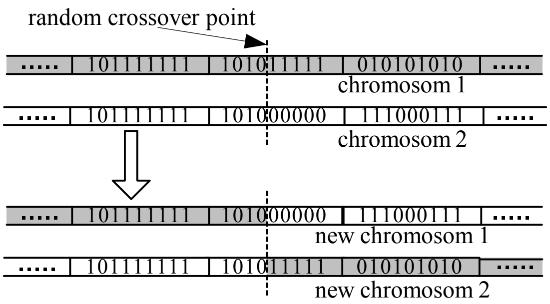

Fig. 1. Diagram of the crossover operation

In a mutation process, genes may change their values. For each gene of every members of the new generation, a random decision with a given probability is made. If the mutation is to take place, the value of the bit is changed.

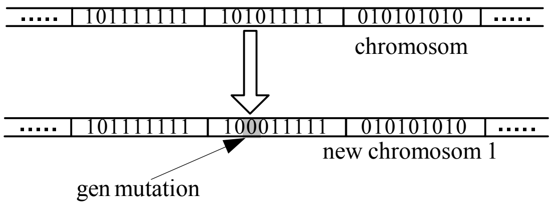

Fig. 2. Diagram of the mutation operation

III. Results of Estimation

The Algorithms for Optimization Toolbox (GAOT) [3] library of the Matlab software was used for the calculations. The library contains subroutines for defining and selecting the method parameters, such as the evaluation function, determination of the boundary conditions for the estimated parameters, specification of the population size, settings for the closing condition, and criteria for the selection, mutation and crossover operations.

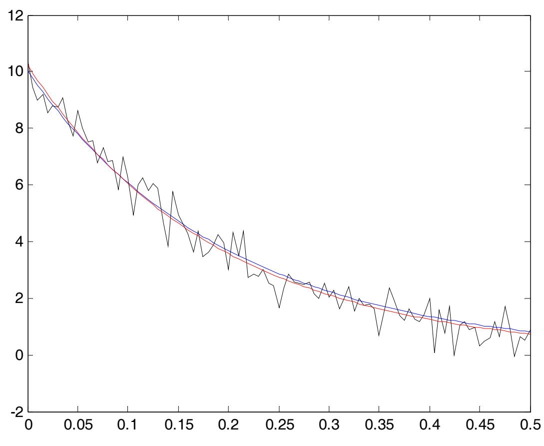

Fig. 3. Measurement signal with and without noise and the approximation. Number of signal samples N=100, noise variance=0.5

In order to utilize the GA method effectively, it is imperative to establish the range for the variation of the estimated parameter values (search range).

In order to estimate the parameters, the genetic algorithm has been used for measurement data. It was assumed in the calculations presented in this work.

The obtained values may be used as the parameters in the evaluation function.

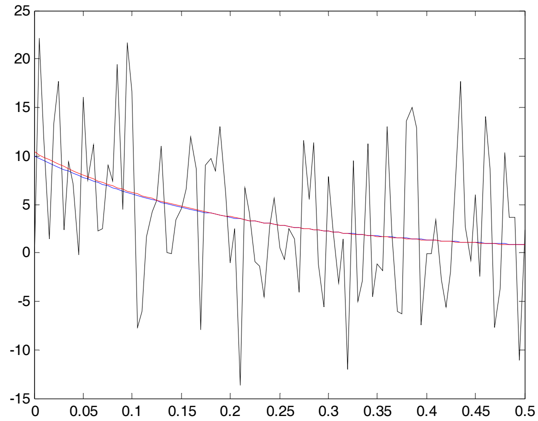

Fig 4. Measurement signal with and without noise and the approximation. Number of signal samples N=100, noise variance=10

The accuracy of the final results was improved through evaluation of the average value of the parameters found in a number of estimations.

The plots of the obtained estimations are shown in Fig. 3 and Fig. 4

IV. Conclusions

Genetic algorithm and numerical differentiation may be accepted as a useful tool for identification of non-stationary signals parameters. A successful implementation of the method requires initial analytical investigations leading to determination of a reasonable search range.

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Voltage fluctuation assessment with application of neural networks

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Abstract- **The paper presents a contribution to voltage fluctuation assessment. The importance of automated power quality assessment, especially voltage fluctuation, is firstly shown. The SVM network is then introduced and considered as an appropriate tool for classification issues. The feature extraction for SVM classifier is done with application of space phasor. Disturbed signals were generated using a model build in Matlab. Finally, the results of classification of disturbed signals are presented.**

I. Introduction

Power quality issues are regarded as highly crucial [1], [2]. Both the power industry and scientific community continuously points out reasons for that, some can be named [3].

Firstly, the deregulation of the electricity marked has caused growing need for performance criteria [4]. Utilities are forced to deliver a good product at affordable price.

Generation of electrical energy take place in large power stations connected to the transmission system and smaller wind generators, which are connected via power electronic devices. The problems of voltage fluctuation and harmonic generation were observed. Power electronic equipment causes disturbances for other customers. On the other hand, electronic and power electronic equipment has become more sensitive to voltage disturbances than its counterparts years ago [2].

The ideal voltage curve in a three phase public electrical network should be characterized as follows [5]: pure sinus form, constant frequency according to the grid frequency, equal amplitudes in each phase according to the voltage level, defined phase-sequence with an angle of 120° between them. Every phenomenon which affects those parameters will be seen as decrease in voltage quality.

In this paper the attention was directed toward voltage fluctuation measurement and characterization.

II. Voltage Fluctuations

Voltage flicker or more actually, voltage fluctuation leading to light flicker are mathematically special case of interharmonic distortion [2], [6]. The voltage during the time of fluctuation (flicker) can be expressed mathematically as [8]

$$v(t) = \left(A_0 + \sum_{i=1}^{M} \left\{ A_i \cos\left(\omega_{fi} t + \varphi_{fi}\right) \right\} \right) \cos\left(\omega_0 t + \varphi_0\right) \tag{1}$$

where A_0 is the amplitude of the voltage, ω_0 is the power frequency, and φ_0 its phase angle. Furthermore A_i is the amplitude of the flicker voltage, ω_i is its frequency, and φ_{fi} is its phase angle.

For $M = 1$ and φ set to zero the above equation can be expanded into [2]

$$v(t) = A_0 \begin{bmatrix} \cos\omega_0 t + \dfrac{A_1}{2}\cos\left(\omega_0 + \omega_{f1}\right)t + ... \\ + \dfrac{A_1}{2}\cos\left(\omega_0 - \omega_{f1}\right)t \end{bmatrix} \tag{2}$$

Voltage fluctuation not only disturbs the human eye but also can damage sensitive equipment or the performance of it can be affected [1]. The concept of voltage fluctuation involves voltage magnitude and frequency occurrence [6].

Common sources of flicker are wind turbines, frequent starting of electric motors and their operation in applications that require an irregular torque such as compressors or pumps.

III. Support Vector Machines and Space Phasor

In recent years, a new approach was developed to construct and train neural networks, which is free of disadvantages [9], as local minima or complexness of the architecture. New networks are called Support Vector Machines (SVM) [9].

SVM implements a special training algorithm maximizing the separating margin between two classes given by a set of data pairs (sample, class) (x_i, d_i).

SVM are unidirectional, have two layers and can implement different activation functions: linear, polynomial, radial or sigmoidal. In order to construct sufficiently distinctive patterns for the SVM classifier, the idea of the space phasor was applied.

$$\begin{bmatrix} f_1 \\ f_2 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} \tag{3}$$

IV. Network under Study

The study involved a 15 kV supply. The diagram is shown in Figure 1. It consists of System Equivalent characterized through short circuit power (Sk''=3 GVA), delta - wye connected transformer (n=110/16.5, SN=10 MVA) and an overhead distribution line. The load and flicker source are connected at bus S3.

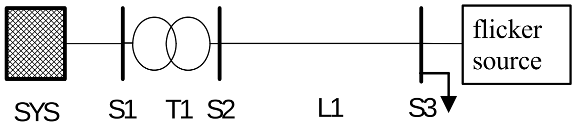

Figure 1. Model of the supply system with a load causing voltage fluctuations

The flicker source was constructed as described in detail in [7]. The voltage and current meters were connected to bus S3, where the power quality was observed.

V. Research Results

During this research several different voltage fluctuation forms were simulated.

In Figure 2 the frequency of the inner source was set to 1 Hz, but for the other signals used in this particular research it varied between 1 and 30 Hz with a step of 2 Hz. The simulation time was set to 0.2 seconds and sampling time to 0.5 ms

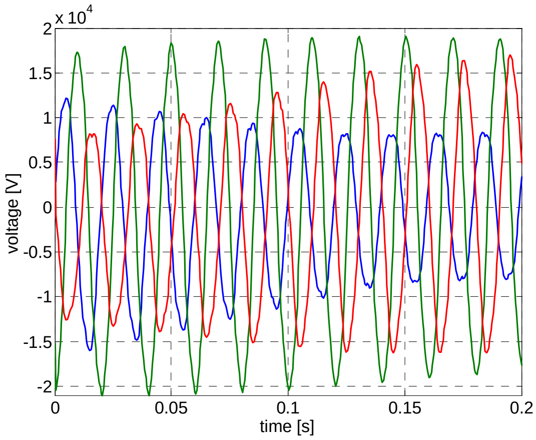

Figure 2. Three phase voltage at bus S3 (flicker source frequency 1 Hz)

An attempt to automatically classify voltage fluctuations with different frequency contents was undertaken. Three groups were set for the investigated signals. They were chosen in accordance to the frequency of inner voltage source of flicker load, around 5, 15 and 25 Hz. The SVM classifier was trained with signals typical for each of these groups. Only one vector for every class was presented to the SVM network in learn phase. Test results are shown in Table 1. Each row represents a frequency class (5, 15 or 25). In columns the classification rate is included.

Good classification rates in Table 1 should be correctly interpreted. The frequency of inner voltage source of flicker load was changed with the step of 2 Hz in the range from 1 to 30 Hz (15 signals totally). For 5Hz class the signals with 3 and 7 were classified correctly, for 15Hz class 13 and 17 respectively. Other signals (1, 9, 11, 19, 12, 29 Hz) were the border between different classis. They were not properly classified. The classification rate of 0.5 for 5 Hz class was obtained because 3 and 7 Hz signals were classified correctly, and 1 and 9 Hz signals (theoretically belonging to 5 Hz class) were recognized as 25 Hz class and 15 Hz class respectively.

TABLE I
Classification Results

	class 5 Hz	class 15 Hz	class 25 Hz
class 5 Hz	0.5		
class 15 Hz		1	
class 25 Hz			1

It was possible to minimize the area of uncertainty through presenting more training vectors for each class and decreasing the frequency change step. This should be done for each particular problem individually in accordance to required accuracy and acceptable training efforts.

VI. Conclusion

In this paper a neural network approach to classification of voltage fluctuations was presented. Although the differences are rather small the SVM network is able to recognize the fluctuations. The SVM neural networks have shown satisfactory classification abilities. Nevertheless the classification accuracy depends on class spread and training effort. This should be chosen individually for a given problem. Proposed algorithm could be integrated into more extensive power quality monitoring system.

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Thin Film Arresters Obtained by Metal Evaporation

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Abstract- **Ceramic varistors based on zinc oxide have been shown to have excellent properties as protection devices used in power industry. However their breakdown voltage, dependant on number of grain boudaries, is too high for use in electronic applications. In this article performace of micro-devices having varistor-type current-voltage (I-V) characteristics with low breakdown voltage is reported.**

I. Introduction

Oxide varistors are mainly manufactured using ceramic technology. Powdered metal oxides: ZnO making the matrix, Bi_2O_3 and, in small amounts, other metal oxides as Al_2O_3, Co_3O_4 and MnO_2 are mixed together, pressed into pellets and then sinterred. Mass varistors obtained this way have highly non-linear current-voltage (I-V) characteristics. The shape of the varistor I-V characteristics is determined not only by the bulk material chemical composition but also by parameters of its thermal treatment [1]. In the microstructure of varistor ceramics three main constituents may be distinguished: semiconducting grains of ZnO, a matrix of intergranular insulating phase, rich in bismuth and junctions between grains and the intergranular phase. The research points out to the fact, that the junctions formed on the border between ZnO grains and the intergranular phase are responsible for a potential barrier rise, which controll the current flow through the bulk of the ceramics [2, 3]. The breakdown voltage of varistors produced using ceramic technology is then dependant not only on the breakdown voltage of a single junction but also on the number of, connected in serial, junctions situated across the thickness of the device. Applications of the varistors in protection of fragile electronic circuits demand sufficiently low value of the breakdown voltage but this is impossible to attain when using classical ceramic technology. Such prospects are however created by thin-film technologies, making it possible to obtain layers with thickness comparable to the size of a single grain of ZnO [4-7]. These techniques are also compatible with processes utilised in microelectronic industry thus enabling incorporation of thin-film varistors in LSI circuits and gas sensors. Zn-Bi-O thin films prepared by magnetron sputtering exhibit H_2 sensitivity [8] and could be used in gas sensors.

II. Experimental

The specimens were prepared as a two-component Zn-Bi system. Zinc and bismuth, 92% and 8% by weight respectively, were subjected to a calcination. The material prepared in this way was then deposited by thermal evaporation onto carefully cleaned and polished substrates made of a nickel sheet. This metal substrate served also the purpose of one of the electrodes in subsequent measurements of the electrical properties. The evaporation process was carried out using 99.99% purity materials in $p=10^{-3}$ Pa vacuum. The substrates were then machine cut into pieces having dimensions of 5 by 10 mm. Samples were placed in the oven and hold at a temperature of 400 °C for 5 hours in order to oxidise Zn-Bi layer. This process was followed by annealing phase when the temperature was risen up to 800 °C to obtain structures having various grain size distribution thus various electrical properties. Finally the second electrode was deposited at the top of a thin-film varistor device by means of a silver target RF sputtering.

Microstructure of the specimens was investigated using SEM (Scanning Electron Microscopy) and X-ray microprobe. Their electrical properties were measured by means of a computerised set-up with Keithley 617 electrometer.

III. Results and Discussion

Fig. 1 shows I-V characteristics of ZnO- Bi_2O_3 structures obtained by means of a pure metal evaporation as well as the effect of the annealing temperature variation. For low temperatures, not exceeding 700 °C, I-V characteristics not exhibit varistor type of behavior. Increase of the annealing temperature results in the nonlinear I-V dependence. In low voltage range, up to app. 3 V, the current-voltage dependence is strictly ohmic. In higher voltage range, above the threshold value (equal to the breakdown voltage) the I-V characteristics starts to bent and the current-voltage dependence becomes nonlinear and well described by $I=f(V^{\alpha})$ type function

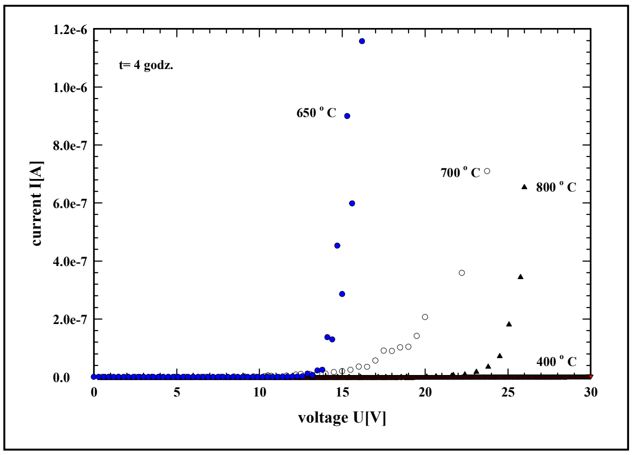

Figure 1. I-V characteristics of ZnO- Bi_2O_3 structures deposited by means of thermal evaporation, annealed at different temperatures.

It may be attributed to the thermally stimulated change of the mean grain size, which becomes evident when observing Fig. 2, showing exemplary SEM scans of the varistor structures.

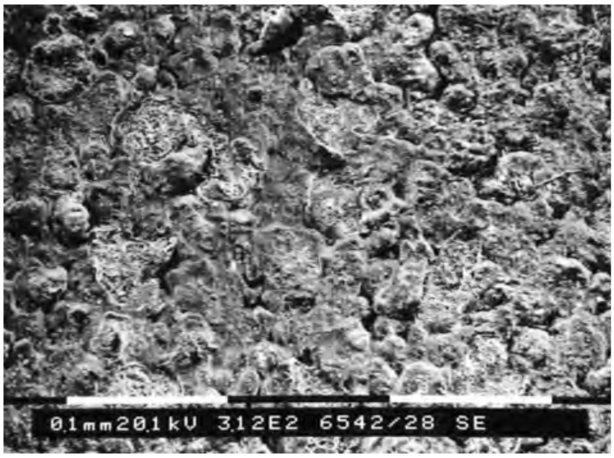

Fig. 2 Structure of ZnO-Bi_2O_3 layers deposited on corundum substrate, annealed at 800 ^oC.

Fig. 3 shows results of X-ray diffraction analysis (XRD) using CuKα radiation. It can bee seen from Fig. 3, that - for films annealed at 400 ^oC – only background peaks appear. This could bee attributed to amorphous nature of the material. Crystal structures start develops as the annealing temperature increases. XRD spectra for the film annealed at 700 ^oC shows new peaks at diffraction angle $2\Theta=20^o$ – 35^o, which is correlated to crystal phase formation. XRD spectra for the film annealed at 800 oC shows high intensity peaks at the same diffraction angle ($2\Theta=20^o$ – 35^o) and background peaks fading. The most intensive pikes are those attributed to Zn and Bi. It could be attributed to crystal nature of the material.

As the annealing temperature increases, the crystalline nature slowly develop and the films annealed at 800 ^oC exhibit strong varistor type of behavior.

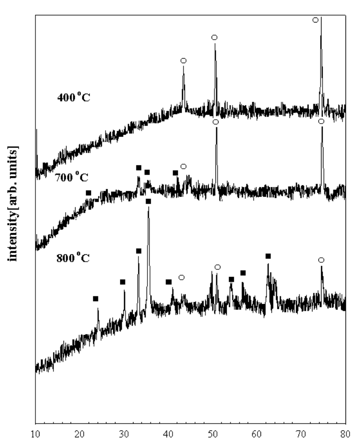

Figure 3. XRD spectra of thermally evaporated thin films of ZnO-Bi_2O_3 annealed at different temperatures.

The thickness of the investigated ZnO- Bi_2O_3 composite layers, estimated on the basis of SEM scans of their fracture, was equal to 8 μm.

IV. Conclusions

The shape of I-U characteristics measured for varistor thin-film structures allows us to conclude that even in such a simple bicomponent system it is already possible to obtain a varistor effect with relatively low breakdown voltage. It is made possible when thermal vacuum evaporation of pure metals is applied as a deposition process. Moreover, controll of the device electrical properties, particularly its breakdown voltage, is possible when the right conditions of the subsequent thermal treatment are selected (temperature and time of annealing and cooling).

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Analysis of Non-Stationary Signals in Power Systems using Wigner Transform and Min-Norm Method

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Abstract- **Time-varying spectra of non-stationary time-series commonly used are spectrograms from the Short-Time Fourier Transform (STFT). The most prominent limitation of the Fourier Transform is that of frequency resolution. To overcome the limitations the Wigner-Ville Distribution and the Min-Norm subspace method have been applied for spectrum estimation of non-stationary signals caused by switching on capacitor banks and by a short circuit at the output of a frequency converter. Investigation results confirm the advantages of the advanced methods.**

I. INTRODUCTION

The aim of signal analysis is to extract relevant information from a signal by transforming it. Spectrum estimation of discretely sampled deterministic and stochastic processes is usually based on procedures employing the Fast Fourier Trans-form (FFT). Conventional FFT spectral estimation is based on a Fourier series model of the data, that is the process is assumed to be composed of a set of harmonically related sinusoids. This approach to spectrum analysis is computationally efficient and produces reasonable results for a large class of signal processes. In spite of these advantages there are several inherent performance limitations of the FFT approach. The most prominent limitation is that of frequency resolution, i.e. the ability to distinguish the spectral responses of two or more signals. Because of some invalid assumptions (zero data or repetitive data outside the duration of observation) made in this methods, the estimated spectrum can be a smeared version of the true spectrum. A second limitation is due to windowing of the data, that occurs when processing with the FFT. Windowing manifests itself as leakage in the spectral domain – energy in the main lobe of a spectral response leaks into the side-lobs, obscuring and distorting other spectral responses that are present. These two performance limitations of the FFT approach are particularly troublesome when analyzing short data records. Short data records occur frequently in practice, because many measured processes are brief in duration or have slowly time-varying spectra, that can be considered constant only for short record lengths. In an attempt to alleviate the limitations of the FFT approach, many alternative spectral estimation procedures have been proposed within the last 4-5 decades.

In the case of a non-stationary signal, any change of the signal causes a continuous spectrum which spread out over the whole frequency axis. Therefore other methods of analysis are needed, to get a two-dimensional time-frequency representation $S(t,\omega)$ of the investigated signal. First, Gabor has adapted the Fourier Transform to define the $S(t,\omega)$, assuming that the signal is stationary when seen through a window of limited extent. This yields the Short-Time Fourier Transform (STFT). The time varying spectra of non-stationary time series commonly used are spectrograms, from the STFT. If a signal is composed of small bursts of components, then each type of component can be analyzed with good time resolution or frequency resolution, but not both. To overcome the resolution limitation, the Wavelet Transform (WT) has been applied. [7].

The subspace frequency estimation methods rely on the property that the noise subspace eigenvectors of a Toeplitz autocorrelation matrix are orthogonal to the eigenvectors spanning the signal space [2]. The model of the signal in this case is a sum of random sinusoids in the background of noise of a known covariance function. The eigenvectors spanning the noise space are the ones whose eigenvalues are the smallest and equal to the noise power. One of the most important techniques, based on the concepts of subspaces is the Min-Norm method [4].

Transients resulting from the switching capacitor banks in electrical distribution systems affects power quality. The estimation of parameters of transient components is very important for design of protection and control instruments. The transient waveforms have been investigated using Wavelet Trans-form (scalograms) and Wigner-Ville Distribution.

Reliability of power electronic drive systems is important in many industrial applications. The analysis of fault mode behavior can be utilized for development of monitoring and diagnostic systems. In this paper we present also some results of simulation investigations of a converter-fed induction motor drive. PWM converters supplying asynchronous motor were simulated. Detection of irregular frequencies may be useful for diagnosis of some drive faults.

Spectrum of the signal was estimated with the help of the Wigner-Ville Distribution (WVD) and Min-Norm method (which belongs to the group of subspace methods).

II. WIGNER-VILLE REPRESENTATION

The Wigner-Ville distribution is expressed by:

$$W_x(t,\omega) = \int_{-\infty}^{\infty} x\left(t+\tfrac{\tau}{2}\right) x^*\left(t-\tfrac{\tau}{2}\right) e^{(-j\omega\tau)} d\tau \quad (1)$$

where t is a time variable, ω is a frequency variable and * denotes complex conjugate.

For a discrete-time signal $x(n)$ the discrete pseudo-Wigner-Ville distribution (PWD) is evaluated using a sliding symmetrical finite-length analysis window $h(\tau)$ [6].

$$W_{xh}(n,k) = 2\sum_{\tau=-L}^{L} x(n+\tau)x^*(n-\tau)\times h(\tau)h^*(-\tau)e^{-j4\pi k\tau/N} \quad (2)$$

where $h(\tau)$ is a windowing function that satisfies the condition: $h(\tau)=0; |\tau|>L$. Variables n and k correspond respectively to the discrete time and frequency variables. The Wigner-Ville distribution of a signal can attain negative values. Each time-frequency representation, which preserves marginal conditions cannot be positive everywhere. These local negative values does not have any physical meaning.

One main deficiency of the WVD is the cross-term interference. WVD of the sum of signal components is a linear combination of auto- and cross-terms. Each pair of the signal components creates one additional cross-term in the spectrum, thus the desired time-frequency representation may be confusing.

Traditionally, the cross-terms are considered as something undesired in the WVD [6] and should be removed. One way of lowering cross-term interference is to apply a low-pass filter to the WVD. The smoothing, however, will reduce the frequency resolution of the WVD and cause the loss of some useful properties of the transformation [5].

III. Modified Min-Norm Method

The Min-Norm method involves calculation of the correlation matrix of the signal. Smallest eigenvalues of the matrix correspond to the noise subspace and largest (all greater than the noise variance) correspond to the signal subspace. The matrix of eigenvectors is defined by:

$$\mathbf{E}_{noise} = \left[\mathbf{e}_{M+1} \quad \mathbf{e}_{M+2} \quad \cdots \quad \mathbf{e}_N\right] \quad (3)$$

N-M smallest eigenvalues of the correlation matrix (matrix dimension $N>M+1$) correspond to the noise subspace and M largest (all greater than σ_0^2) corresponds to the signal subspace.

Min-norm method uses one vector $\mathbf{d}$ for frequency estimation. This vector, belonging to the noise subspace, has minimum Euclidean norm and his first element equal to one. We can present $\mathbf{E}_{noise}$ in the form

$$\mathbf{E}_{noise} = \begin{bmatrix} \mathbf{c}^{*T} \\ \mathbf{E}'_{noise} \end{bmatrix} \quad (4)$$

where $\mathbf{c}^{*T}$ is the upper row of the matrix. Hence $\mathbf{c} = \mathbf{E}^{*T}_{noise}\ell$, where $\mathbf{d}^{*T}\ell = 1$. These conditions are expressed by the following equation:

$$\mathbf{d} = \frac{1}{\mathbf{c}^{*T}\mathbf{c}}\mathbf{E}_{noise}\mathbf{c} = \begin{bmatrix} 1 \\ \left(\mathbf{E}'_{noise}\mathbf{c}\right)/\left(\mathbf{c}^{*T}\mathbf{c}\right) \end{bmatrix} \quad (5)$$

Pseudospectrum defined with the help of **d** is defined as:

$$\widehat{P}\left(e^{j\omega}\right) = \frac{1}{\left|\mathbf{w}^{*T}\mathbf{d}\right|^2} = \frac{1}{\mathbf{w}^{*T}\mathbf{d}\mathbf{d}^{*T}\mathbf{w}} \quad (6)$$

where $\mathbf{w}$ is defined as: $\mathbf{w} = \left[1 \quad e^{j\omega_i} \quad \cdots \quad e^{j(N-1)\omega_i}\right]^T$

Since each of the elements of the signal vector is orthogonal to the noise subspace, the $\widehat{P}\left(e^{j\omega}\right)$ (6) exhibits sharp peaks at the signal component frequencies.

In order to adapt this high-resolution method for analysis of non-stationary signals we use similar approach as in short-time Fourier transform (STFT). The time varying signal is broken up into minor segments (with the help of the temporal window function) and each segment (possibly overlapping) is analyses.

The denominator of (6) is estimated for the each time instant. Instantaneous estimates of (6) can be used as estimates of the instantaneous frequency of the signal [4].

IV. Investigations

A. *Switching of Capacitor Banks*

In the paper, investigation results in a distribution system as in Fig. 1 are shown. Two capacitor banks (CB) were installed along the feeder. Several cases were simulated and both currents and voltages were recorded. Fig. 2 shows the current waveform at the beginning of the feeder for the case that the first CB (900 kVAr) was switched on at 0.03s and the second CB (1200 kVAr) at 0.09s.

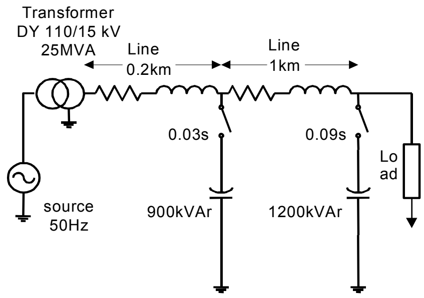

Fig. 1 One-phase diagram of the simulated distribution system.

Wigner-Ville Distribution offers the possibility to track the frequency and amplitude changes of a non-stationary signal. When applying the WVD for analyzing the current signal in Fig. 2, the components 50 Hz, 270 Hz and 475 Hz have been detected (Figs. 3, 4, 5), which are close to expected. However, appearance of cross-terms (110 Hz and 160 Hz) is difficult to explain. The Wigner-Ville representation allows immediate determination of the time point of the commutation incipience.

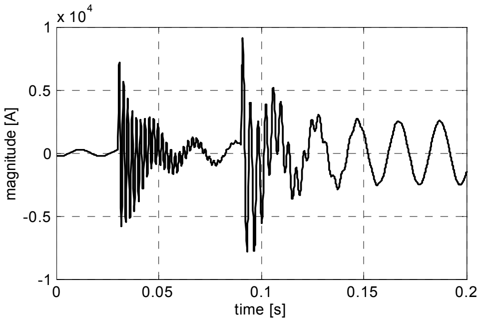

Fig. 2. Current waveform at the beginning of the feeder during subsequent switching of two capacitor banks.

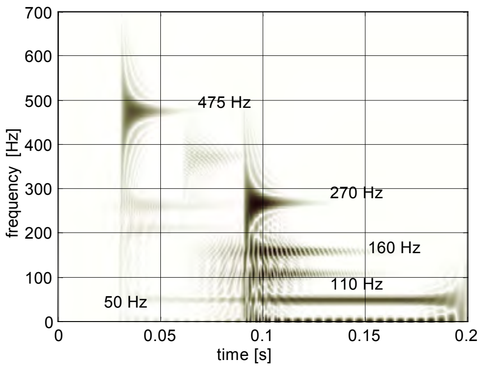

Fig. 3. Time frequency representation of the signal from Fig. 1 (switching of the capacitor banks), obtained using the Wigner-Ville Distribution (with Gaussian smoothing).

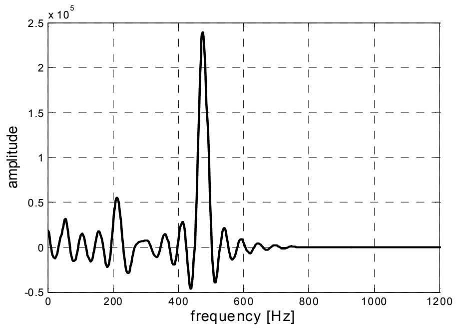

Fig. 4. Cross-section of the time-frequency representation from Fig. 3 for the time t=0.04 s.

B. *Fault operation of the Inverter Drive*

In the paper we show investigation results of a 3kVA-PWM-converter with a modulation frequency of 1 kHz supplying a 2-pole, 1 kW asynchronous motor (supply voltage 220 V, nominal power 1,1 kW, slip 6 %, cosφ =0,81. (Fig. 9). Characteristic RC-damping components at the rectifier bridge and at the converter valves are considered. To design the intermediate circuit, the L, C values of a typical 3 kVA converter are chosen. Fault operation of the inverter drive was considered short-circuit between motor leads which occurs at the time 0.1 s (Fig. 6) Main frequency of the inverter 60 Hz, sampling frequency 20 kHz. The current signal spectrum has been calculated using the Min-Norm subspace method (Figs. 8, 9) and the Wigner-Ville Distribution (Figs. 10, 11, 12).

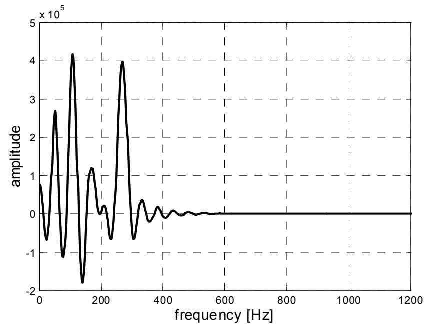

Fig. 5. Cross-section of the time-frequency representation from Fig. 3 for the time t=0.1 s.

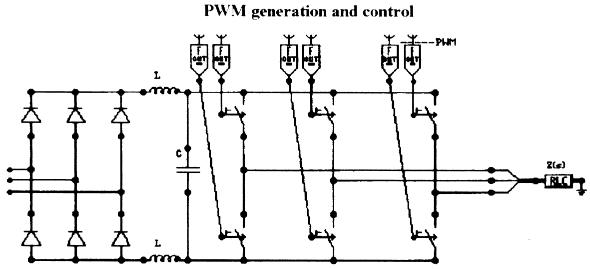

Fig. 6. Diagram of the simulated inverter drive.

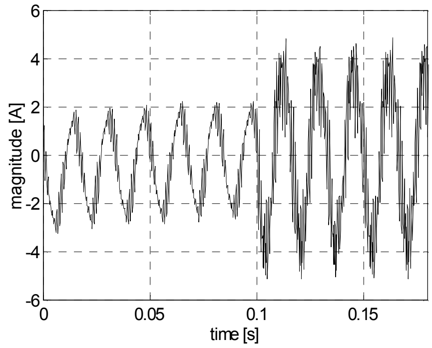

Fig. 7. Current waveform at the inverter output.

In the case after the short circuit appears, the Min-Norm method enables to detect two inter-modulation frequencies (880 Hz and 1120 Hz), and two additional components (1920 Hz and 2070 Hz).

Thanks to its high-resolution properties, the Min-Norm method is especially suitable for identification and frequency estimation of signal components, which frequencies differ slightly. Detection of the additional higher frequency component can be applied as the fault indicator. The results obtained when using WVD are not satisfactory (Fig. 10). Before and after the fault appears the basic component, which has been detected. The modulation components (1000 Hz) has been detected only after the fault appearance, when the amplitude of the component is high enough. Unfortunately, the appearance of non-existent component of about 500 Hz becomes evident.

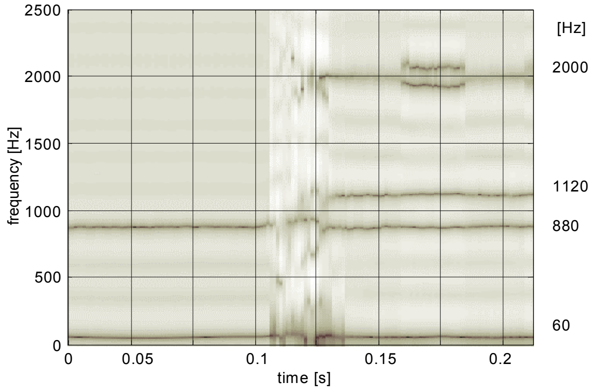

Fig. 8. Time frequency representation of the signal taken from fault operation of the frequency converter, obtained using the Min-Norm method. (window length 80 samples, sampling frequency 20 kHz).

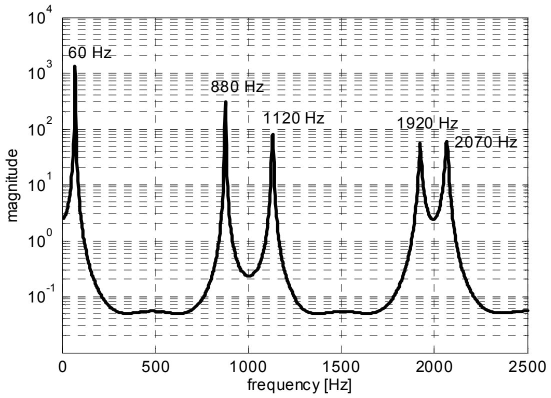

Fig. 9. Cross-section of the time-frequency representation from the Fig. 8 for the time instant t=0.17 s.

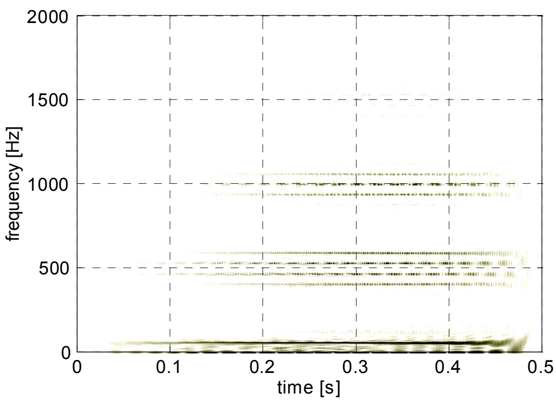

Fig. 10. Time frequency representation of the signal taken from the fault operation of the frequency converter, obtained using the Wigner-Ville Distribution (with Gaussian smoothing).

The cross-term interference components appear at frequencies which lie between the frequencies of two strong components. The amplitude of these components is often oscillating (as in Fig. 3 for the components with frequencies 110 and 160 Hz). As already mentioned, the way of lowering cross-term interference is to apply a low-pass filter to the WVD. In practical situations it does not always remove all artefacts and reduces the frequency resolution.

V. CONCLUSIONS

Transients resulting from the switching capacitor banks and fault operation of the frequency converter in electrical distribution systems affect power quality. Modern frequency power inverters generate a wide spectrum of harmonic components. Detection of all signal components can be effectively used to identify faults in inverter. The parameters of transient components have been analysed using the Wigner-Ville distribution and subspace method. The Wigner-Ville spectrum of signals with time limited windows shows better frequency concentration and less phase dependence than Fourier spectra. The investigations show the advantages of the method basing proposed methods. However, the Wigner-Ville distribution offers advantages when analysing signals with few components only. It allows in the case of the signal obtained during switching of capacitor banks, immediate determination of the time point of the commutation incipience and amplitudes of respective components. In the case of multi-component signals (frequency converter), due to the appearance of cross-terms, obtained representation is difficult to interpret. By comparing the Wigner-Ville and min-norm representation the appearance of non-existent component of about 500 Hz becomes evident. In this case better results gives the subspace method, which allows the determination of the frequencies of the spectral components with high accuracy and does not suffer from the appearance of artefacts. Due to its high-resolution properties, the Min-Norm method is especially suitable for identification and frequency estimation of signal components, which frequencies differ slightly.

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The genetic algorithm using to the analysis of thermally stimulated currents spectrum

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Abstract- **In order to separate individual relaxation processes and estimate the corresponding parameters, the genetic algorithm has been used [4]. The genetic algorithms belong to a wide class of optimization methods, which imitate processes taking place in nature. They are numerical procedures that utilize random choices in a highly directed search of the optimal solution. The algorithms are durable and effective in analyzing processes in very complicated solution spaces [5], such as the estimation of a complex TSD spectrum.**

I. Introduction

The characteristic points [1, 2] or the initial rise [3] of the relaxation peak are used in the classical analysis of the relaxation processes in thermally stimulated current (TSD) spectra. The result of a TSD measurement is a superposition of several relaxation processes. The resulting complexity of the spectrum makes the analysis difficult, while the parameters describing the relaxation process carry a large error.

II. Genetics AlgoRithms (GA)

Biological concepts are utilized in the genetic algorithms. The population members, each being a point in the solution space, are transformed in an evolutionary process. The initial population is selected randomly. A fitness function is used to evaluate each member of the population. The best adapted members are selected for the next population, while other members undergo modification using genetic transformations (mutation and crossover). In this manner, the next approximation of the solution is obtained. The consecutive populations are processed in the same way until the required criterion is met. The most adopted member of the final population is accepted as the solution to the optimization problem.

In order to estimate the relaxation parameters for the experimental TSD spectrum, the minimum of the approximation error has been selected as the adaptation criterion:

$$\varepsilon = \sum_{T=T_0}^{T_{Lim}} \left[\tilde{j}(T) - j(T) \right]^2 . \qquad (1)$$

where the approximation functions were calculated from the following relation

$$\tilde{j}(T) = \sum_{k=1}^{4} \left\{ \frac{P_{0k}}{\tau_{0k}} \exp\left(-\frac{E_{ak}}{kT}\right) \exp\left[-\frac{1}{\tau_{0k} b} \int_{T_0}^{T} \exp\left(-\frac{E_{ak}}{kT'}\right) dT' \right] \right\} . \qquad (2)$$

τ_{0k} – characteristic relaxation time, E_{ak} – trap energy, k – Boltzmann constant, N number of relaxations, T_0 – initial temperature, P_{0k} – initial polarization value

The individual relaxation parameters (E_{ak}, τ_{0k}, P_{ok} ,) were properly coded and processed with the genetic algorithm.

III. Experimental details

The samples under study were made of indium doped Cd1-xMnxTe. From the photoluminescence and optical absorption studies, the content of manganese, was determined to be about x = .15. The studied material exhibited sufficiently high electrical resistivity, therefore, it was possible to implement the thermally stimulated discharge current method (TSDC) to investigate electronic properties of the traps in this material

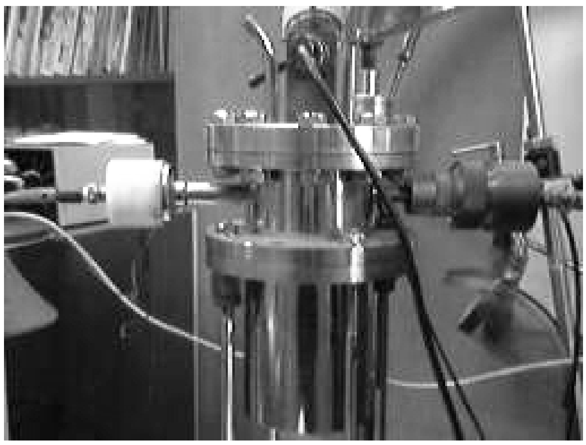

Fig. 7. The system used for data collection

Thermally stimulated discharge current spectra were collected in the 80 K – 300 K temperature range. The presence of four charge carrier traps has been identified in the material (indium doped $Cd_{0.85}Mn_{0.15}Te$). The activation energies were determined from the initial slope of each feature and from the best fit of the experimental results to equation (2) using the GA method.

IV. RESALTS OF ESTIMATION

The Algorithms for Optimization Toolbox (GAOT) [6] library of the Matlab software was used for the calculations. The library contains subroutines for defining and selecting the method parameters, such as the evaluation function, determination of the boundary conditions for the estimated parameters, specification of the population size, settings for the closing condition, and criteria for the selection, mutation and crossover operations. In order to separate individual relaxation processes and estimate the corresponding parameters, the genetic algorithm has been used for measurement data. It was assumed in the calculations presented in this work, that approximate values of the activation energies E_{ak} for individual relaxations were known. It was also understood that the temperature values T_{mk}, corresponding to maxima in the TSDC spectrum, as well as the maximum current densities $J_{mk} = J(T_{mk})$ were properly determined from the experimental data. The obtained values may be used as the parameters in the evaluation function.

Two different estimation methods for the parameter were used:

- direct estimation of the parameters ($E_{ak}, P_{0k}, \tau_{0k}$); Analytical calculation was used for initial exploration of the searched parameters leading to the investigation range.
- indirect determination of the exact parameters ($E_{ak}, P_{0k}, \tau_{0k}$) through the estimation of the related values (E_{ak}, J_{mk}, T_{mk}); In this case, the investigation range for the GA method was established as the deviation from the values obtained in the experimental data.

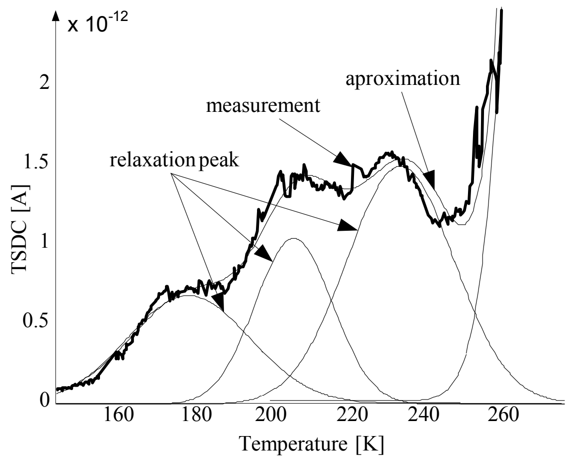

Figure 1. Average values of the TSDC relaxation parameters obtained with the GA method

The accuracy of the final results was improved through evaluation of the average value of the parameters found in a number of estimations.

The plots of the obtained estimations are shown in Fig. 1. The corresponding function parameters are listed in Table 1.

TABLE I

The analysis of a TSDC spectrum using the GA

	Peak 1	*Peak 2*	*Peak 3*	*Peak 4*
E_a (eV)	*2.5 e-01*	*2.8 e-1*	*4.5 e-1*	*7.8 e-1*
P_0(C/cm^2)	*0.30 e-09*	*0.88 e-9*	*0.85 e-9*	*0.90 e-8*
τ_0 (s)	*1.15 e-5*	*3.6 e-5*	*3.5 e-8*	*2.0 e-12*

V. CONCLUSIONS

Genetic algorithm method may be accepted as a useful tool for identification of the TSDC relaxation parameters, described by relation (2). A successful implementation of the method requires initial analytical investigations leading to determination of a reasonable search range. Genetic algorithm yields values of activation energies comparable with those obtained in other experimental techniques (Table 2) where DLTS - Deep Level Transient Spectroscopy and PL – Photoluminescence .

TABLE II

Energy in eV, required for freeing trapped charge carriers obtained in DLTS, TSDC and PL

Label	DLTS	TSDC	PL
E_{a1} (eV)	-	0.25	0.10
E_{a2} (eV)	-	0.28	0.25
E_{a3} (eV)	0.48	0.45	0.40
E_{a4} (eV)	0.76	0.78	-

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Optimal Sizing of Fixed Capacitor Banks Placed on a Distorted Interconnected Distribution Networks by Genetic Algorithms

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Abstract- **In this paper, the optimal sizing of fixed capacitor banks problem in a distorted interconnected distribution system is formulated and solved by a Genetic Algorithm (GA) solution technique to minimize the cost of power production and capacitor banks under the constraints include voltage limits , sizes of installed capacitors and Total Harmonic Distortion (THD), the algorithm is applied on IEEE 30-bus test system and the results are given for different cases: Light and heavy harmonic cases. Computer simulation shows that the harmonic components affect the optimal capacitor sizing.**

I. INTRODUCTION

Capacitors have been commonly used to provide reactive power compensation in distribution systems in order to reduce power losses, regulate bus voltage and improve power factor. The capacitor placement problem is a well-researched topic. Earlier approaches differ in problem formulation and the solution methods. In some approaches, the objective function is considered as an unconstrained problem [1]. Some have formulated the problem as constrained optimization and included voltage constraints into consideration [2].

Capacitor values are often assumed as continuous variables whose costs are considered as proportional to capacitor size in past researches [3], [4]. However, commercially available capacitors are discrete capacities and tuned in discrete steps. Moreover, the cost of capacitor is not linearly proportional to the size (kVar). Hence, if the continuous variable approach is used to choose integral capacitor size, the method may not result in an optimum solution and may even lead to undesirable harmonic resonance conditions.

While most works have been studied by many researchers on capacitor placement in balanced distribution system , very few research is related to capacitor placement in unbalanced distribution systems [5]-[7].

In today's power system, there is a general trend to use more nonlinear loads such as energy-efficient fluorescent lamps and solid-state devices. The capacitors' sizing and allocation should be properly considered, if else they can amplify harmonic currents and voltages due to possible resonance at one or several harmonic frequencies. This condition could lead to potentially dangerous magnitudes of harmonic signals, additional stress on equipment insulation, increased capacitor failure and interference with communication system [8].

Most of the reported techniques for capacitor placement assume sinusoidal operating conditions. These methods include: nonlinear programming [9], near global methods (genetic algorithms [10]-[16], simulated annealing [17]-[20], tabu search [21] - [24], artificial neural networks [25] and fuzzy set theory [26], [27]). All these approaches ignore the presence of voltage and current harmonics.

Some of the recent publications have taken into account the presence of distorted voltages for solving the capacitor sizing problem. These investigations include: exhaustive search [28], local variations [29], mixed integer-nonlinear programming [30], heuristic methods for simultaneous capacitor and filter placement [31], maximum sensitivities selection and fuzzy set theory [32], genetic Algorithm [33], partial swarm optimization [34].

All above publications have discussed on radial networks, the present paper GA employed to determine the optimal sizing of fixed capacitor banks in an interconnected distribution network with non sinusoidal substation voltages, Commercial package ETAP PowerStation program [35] is used for harmonic load flow analysis.

Many programming languages were used to implement the solution algorithm such as Turbo Pascal [10], C++ [11], FORTRAN [17], Turbo C [22], Borland C [23], and MATLAB [33]. In this paper the solution algorithm was implemented using Microsoft Visual Basic 6 programming language, shown in Figure 1, which is not just a language to program in but a whole graphical development environment.

II. HARMONIC LOAD FLOW STUDY

Using computer simulation, the phenomena of power system harmonics can be modeled and analyzed. The ETAP PowerStation Harmonic Analysis program shown in Figure 2 provides a tool to accurately model various power system components and devices to include their frequency dependency, non-linearity, and other characteristics under the presence of harmonic sources.

Total Harmonic Distortion (THD), is the most popular index to measure the level of harmonic distortion to voltage and current. It is a measure that shows the ratio of the mean-square-root of all harmonics to the fundamental component. For an ideal system, THD is equal to zero. THD is determined by:

$$THD = \frac{\sqrt{\sum_{2}^{\infty} F_i^2}}{F_1}$$

Where F_i is the amplitude of the ith harmonic, and F_1 is that for the fundamental component.

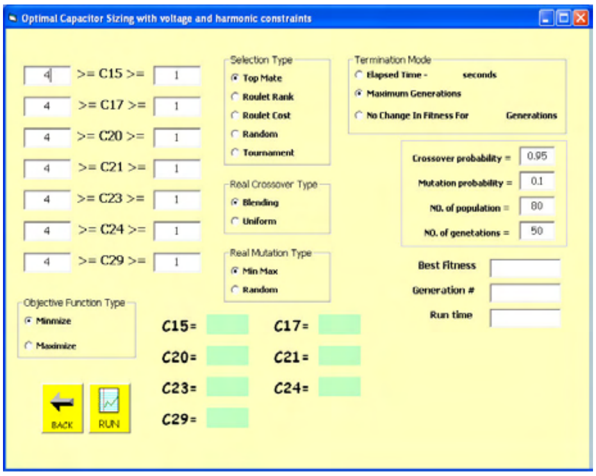

Figure 1. Optimal Capacitor Sizing Program Using VB6

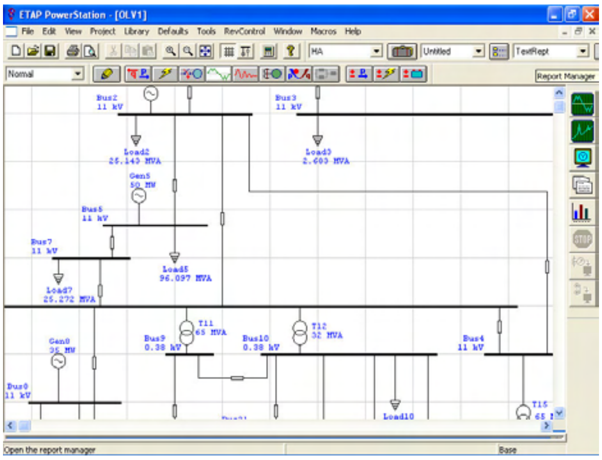

Figure 2. ETAP PowerStation Harmonic Analysis program

The Harmonic Load Flow Study first carries out a load flow calculation at the fundamental frequency. The results of the fundamental load flow sets the base for the fundamental bus voltage and branch currents which are used later to calculate different harmonic indices. Then, for each harmonic frequency at which any harmonic source exists in the system, a direct load flow solution is found by using the current injection method. The harmonic frequencies considered are all the low order frequencies from the 2nd to the 15th, plus the characteristic harmonics from the 17th up to the 73rd. Impedance of components is adjusted based on the harmonic frequencies and the types of components. For a triple harmonic frequency, zero sequence impedance is adjusted to the actual frequency and the zero sequence network is used.

From the harmonic load flow calculation, the harmonic components for bus voltages and branch currents are found, and then all harmonic indices are computed accordingly. The computed bus THD are compared with their limits as specified the IEEE-519 standard [8].

Non-linear loads in power systems are essentially either injecting harmonic currents into the system or applying harmonic voltages at the given points. Therefore, they are conventionally modeled as current sources and voltage sources with harmonic frequencies. Normal power sources such as power grids or generators, if they contain harmonic components in their fixed voltages, are modeled as voltage sources with harmonic frequencies.

A. Harmonic Current Source

Non-linear loads that can be modeled as a harmonic current source in PowerStation are:

1) *Static Load*
2) *UPS (Uninterruptible Power Supply)*
3) *Charger/Converter*
4) *VFD (Variable Frequency Drive)*
5) *Transformer*

Static loads, chargers/converters and VFDs, if they are modeled as a harmonic current source, will inject harmonic current into the connected buses.

When a saturated transformer contributes significant harmonic current into the system (most likely when the transformer is lightly loaded), it can also be modeled as a harmonic current source. Harmonic current source generated by a transformer is normally placed at the primary side; however, if there is a triple nth harmonic current specified for a transformer and the transformer winding and ground connections do not allow the triple nth harmonic current to flow in the primary winding, the secondary side and then the tertiary side will be considered as the location for the harmonic current source.

When a UPS is modeled as a load, it injects harmonic current into the connected bus. On the other hand, if a UPS is modeled as a branch, then it will inject harmonic current into both the AC input bus and the AC output bus. As a result, the path from the AC input bus to the AC output bus inside the UPS will be opened in harmonic load flow calculations.

B. Harmonic Voltage Source

The following components can be modeled as a harmonic voltage source in PowerStation:

1) *Power Grid*
2) *Synchronous Generator*
3) *Inverter*
4) *Charger/Converter*
5) *Static Load*

“Polluted” power grids (utilities) or saturated synchronous generators can be modeled as harmonic voltage sources if they contain significant voltage distortion.

Inverters, chargers/converters, and static loads can also be modeled as harmonic voltage sources if they primarily cause voltage distortion instead of current distortion.

III. Problem Formulation

A. Assumptions

The optimal capacitor sizing problem has many variables including the capacitor size, capacitor cost, and voltage & harmonic constraints on the system. There are switchable capacitors and fixed-type capacitors in practice. However, considering all variables in a nonlinear fashion will make the sizing problem very complicated. In order to simplify the analysis, only fixed-type capacitors are considered with the following assumptions:

1) *Balanced conditions.*
2) *Time-invariant loads.*

B. Objective Function

Most papers consider the transmission loss in the objective function. However, the minimization of loss does not guarantee the minimization of the operation cost unless all units have the same efficiency. Therefore the fuel cost has been used [37].

The objective function used for capacitor sizing is:

$$\text{Min. } C = C_F + C_C \quad (1)$$

$$C_F = \sum_{i \in N_g} C_i(P_i) \quad (2)$$

$$C_i = \begin{cases} a_{i1} + b_{i1}P_i + c_{i1}P_i^2 & \text{if } \underline{P_i} \le P_i < P_{i1} \\ a_{i2} + b_{i2}P_i + c_{i2}P_i^2 & \text{if } P_{i1} \le P_i < P_{i2} \\ \cdots & \\ \cdots & \\ \cdots & \\ a_{im} + b_{im}P_i + c_{im}P_i^2 & \text{if } P_{im-1} \le P_i < \overline{P}_i, \end{cases} \quad (3)$$

Where

C_F: the total power production cost, or more specifically the total summation of generators fuel costs,

C_C: the cost of fixed capacitors,

N_g: the set of generators,

$C_i(P_i)$: cost of the i^{th} generator,

a_{ij}, b_{ij}, c_{ij}: cost coefficients of the i^{th} generator at the j^{th} power level,

P_i: the generated power of the i^{th} generator [MW],

$\underline{P_i}$, $\overline{P}_i$: minimum and maximum real power generation of the i^{th} generator.

C. Constraints

The objective function to minimize the total cost with the following constraints:

$$V_{\min} \le |V_j| \le V_{\max} \quad \text{for } j=1, \ldots, n \quad (4)$$

$$THD_j \le THD_{\max} \quad \text{for } j=1, \ldots, n \quad (5)$$

Bounds for (4), (5) are specified by the IEEE-519 standard [8].

$Q^c_{max} = L\, Q^c_o$

Where:

Q^c_{max}: maximum capacity of the installed capacitor,

L: an integer,

Q^c_o: smallest capacitor size.

IV. Genetic Algorithm

Genetic Algorithm (GA) [38] was first proposed by Holland in the early 1975s [39]. It is an adaptive method simulating the evolutionary process in nature and is based on the principle of nature selection and best survival.

Genetic algorithm is different from other heuristic methods in several ways. The most important difference is that a GA works on a population of possible solutions, while other heuristic methods use a single solution in their iterations. Another difference is that GA is probabilistic (stochastic), not deterministic.

A genetic algorithm approach is developed for optimizing shunt capacitor sizes in interconnected distribution systems with the consideration of harmonic distortion limit.

The genetic algorithm was implemented using optiGA ActiveX control [40] which implements a width range of features as shown on Table I.

TABLE I
OPTIGA FEATURES

Data types	Binary, Real, Integer
Selection methods	Top mate, Roulette rank/cost, Tournament, Random
Crossover methods	One/Two points, Uniform, Blending, User defined
Mutation methods	Flip bit, Random, Min/Max, User defined
Termination methods	Maximum generation, Elapsed time, No change in fitness
Objective function	Minimum, Maximum

Broadly well known, GA is the search method which can consume much time, while finding the global solution; however, in designing and planning of distribution systems, the computation speed searching the optimal solution is not so important. This fact allows one to apply GA if needing an exact solution instead of the computation time.

The genetic algorithm consists of the following main components:

A. Chromosomal Representation

Each chromosome represents a legal solution to the problem and is composed of a string of genes. The binary alphabet {0, 1} is often used to represent these genes but sometimes, depending on the application, integers or real numbers are used. In fact, almost any representation can be used that enables a solution to be encoded as a finite length string.

B. Initial Population

Once a suitable representation has been decided upon for the chromosomes, it is necessary to create an initial population to serve as the starting point for the genetic algorithm. This initial population is usually created randomly. From empirical studies, over a wide range of function optimization problems, a population size of between 30 and 100 is usually recommended.

C. Fitness Evaluation

Fitness evaluation involves defining an objective or fitness function against which each chromosome is tested for suitability for the environment under consideration. As the algorithm proceeds we would expect the individual fitness of the "best" chromosome to increase as well as the total fitness of the population as a whole.

D. Selection

We need to select chromosomes from the current population for reproduction. If we have a population of size 2N, the selection procedure picks out two parent chromosomes, based on their fitness values, which are then used by the crossover and mutation operators (described below) to produce two offspring for the new population. This selection /crossover /mutation cycle is repeated until the new population contains 2N chromosomes i.e. after cycles. The higher the fitness values the higher the probability of that chromosome being selected for reproduction. Here are the selection methods implemented with optiGA:

1) Top mate

The first parent is selected by the fitness order. The second parent is selected randomly.

2) Roulette rank/cost

With this selection method, the chance of a chromosome to be selected is calculated according to their fitness (cost) or according to their rank.

3) Tournament

With this selection method, a small subset of chromosomes is selected and the one with the best fitness will become a parent.

4) Random

This is the simplest method. Parents are simply selected randomly.

E. Crossover

After two parents have been selected by the selection method, crossover takes place. Crossover is an operator that mates the two parents (chromosomes) to produce two offspring. The two newborn chromosomes may be better than their parents and the evolution process may continue. The crossover in carried out according to the crossover probability. Here are the crossover methods implemented by optiGA:

1) One point

A random crossover point is selected. The first part of the first parents is hooked up with the second part of the second parent to make the first offspring. The second offspring is build from the first part of the second parent and the second part of the first parent (the crossover point is noted by the | sign):

Parent #1: 011101|0101
Parent #2: 100111|0111
Offspring #1: 011101|0111
Offspring #2: 100111|0101

(This method is implemented for binary genes only).

2) Two points

The two points crossover operator differs from the one point crossover in the fact that two crossover points are selected randomly:

Parent #1: 011|101|0101
Parent #2: 100|111|0111
Offspring #1: 011|101|0111
Offspring #2: 100|111|0101

(This method is implemented for binary genes only).

3) Uniform

In the uniform crossover each bit/gene is selected randomly, either from the first parent or from the second one:

Parent #1: 0111010101
Parent #2: 1001110111
Offspring #1: 0111010111
Offspring #2: 1001110101

4) Blending

This crossover operator is a kind of linear combination of the two parents that uses the following equations for each gene:

Offspring #1 = parent1 – b * (parent1 – parent2)
Offspring #2 = parent2 + b * (parent1 – parent2)

Were b is a random value between 0 and 1. (This method is implemented for real and integer genes only).

5) User defined

The user defined crossover method is the most powerful one. With this method the user may code his own crossover operator, so the sky is the limit.

F. Mutation

Mutation is the genetic operator that randomly changes one or more of the chromosome's gene. The purpose of the mutation operator is to prevent the genetic population from converging to a local minimum and to introduce to the population new possible solutions. The mutation is carried out according to the mutation probability. Here are the mutation methods implemented by optiGA:

1) Flip bit

This mutation method simply changes (flips) a randomly selected bit:

Before mutation: 0111010101
After mutation: 0111000101

(This method is implemented for binary genes only).

2) Random

The random mutation operator exchange's a random selected gene with a random value within the range of the gene's minimum value and the gene's maximum value. (This method is implemented for real and integer genes only).

3) Min-max

The min-max mutation operator exchange's a random selected gene with the gene's minimum value or with the gene's maximum value, selected randomly. (This method is implemented for real and integer genes only).

4) User defined

The user defined mutation method is the most powerful one. With this method the user may code his own mutation operator, so the sky is the limit.

G. Termination

The termination method determines when the genetic process will stop evolving. Here are the termination methods implemented by optiGA:

1) Maximum generations

The genetic process will end when the specified number of generation's have evolved.

2) Elapsed time

The genetic process will end when a specified time has elapsed.

Note: if the maximum number of generation has been reached before the specified time has elapsed, the process will end.

3) No change in fitness

The genetic process will end if there is no change to the population's best fitness for a specified number of generations.

Note: if the maximum number of generation has been reached before the specified number of generation with no changes has been reached, the process will end.

V. Numerical Results

The solution algorithm was implemented using Microsoft Visual Basic 6 programming language and was executed on a P IV personal computer, Harmonic load flow analysis was implemented by Commercial package ETAP PowerStation program.

The test system is an IEEE 30-bus interconnected network, as the system and load data can be referred to [41].

The capacitor size are regarded as discrete variable and as multiple of a standard bank (2.5Mvar), with investment cost of 0.05 $/hr. For practical installation space consideration, maximum capacity of the installed capacitor is of four banks (10Mvar). In this paper, the candidate buses for capacitor installation are as [37]. The parameters used through the simulation are shown in table II.

Harmonic sources data for case II and case III are shown in table III.

The results are shown in table IV for three different cases; first when all the loads are assumed to be linear, second when light loads are non-linear and finally when all the loads are assumed to be non-linear.

VI. Conclusion

A study of the effect of the system harmonics on calculating the optimum capacitor size , as well as the total cost, for interconnected distribution networks is presented at this work. A genetic algorithm approach is used. The programming is achieved using Visual Basic 6. Commercial package ETAP PowerStation program is used for harmonic load flow analysis, optimal capacitor sizing program used in this work is most effective, simple to use, and it gives better results than that indicates at [37].

Three different cases are introduced; the first with all loads are linear, the second with light loads are non-linear and the third one is the extreme case with all the loads are nonlinear. It was found that the optimal sizes of the capacitors have increased by 12.5% in the case of light harmonics and 37.5% in the heavy harmonic case. Computer simulation shows that the harmonic components affect the optimal capacitor sizing.

TABLE II
Simulation Parameters

Crossover probability	0.95
Mutation probability	0.1
NO. of population	80
NO. of generations	50
Data type	Integer
Selection method	Top mate
Crossover method	Blending
Mutation method	Min/Max
Termination method	Maximum generation
Objective function	Minimum

TABLE III
Harmonic Sources Data

Case II			
Load No.	Type	Manufacturer	Model
2,7,24	Current Source	Typical IEEE	12 pulse VFD
21	Current Source	Rockwell	12 pulse VFD
Case III			
2,3,7,15,20 , 24,29	Current Source	Typical IEEE	12 pulse VFD
17,21	Current Source	Rockwell	12 pulse VFD
26	Current Source	Rockwell	6 pulse VFD

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The Perceived Power Quality Way as New Frontier of Relationships between Customers and Producers

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***Abstract* -The description of perceived power quality state of art is presented. The necessity to satisfy a constant demand of quality in the electric energy field is faced presenting the procedure that should be followed to safeguard the economic interests of the electric energy customers is pointed out with the remarkable by-product to increase the diffusing of the Knowledge of the electric energy by customers.**

***Keywords* - Power Quality (PQ), Perceived Power Quality (PPQ).**

I. Introduction

The Knowledge progress through two steps: the scientific experimentation and the speculation. The first has the role to show the tangible realty allowing us to avoid rough errors, the second allows us to imagine new possible scenarios and help us to establish technical and practical choices. Both steps are necessary to progress and they must be understood by people to obtain the more widespread and more correct interpretation of phenomena.

The fundamental method of the scientific experimentation is the Measure, without it, it is not possible to quantify in no way the entity under control that we want to know, but the finality of the analysis of the Knowledge confine this first step in a world of experts.

On the contrary, the speculation has many facets not necessarily joined to a world of specialists, but open to contributes of the Thought coming from all fields of the human knowledge and from the human sciences, not last the economic one.

To allow the fantasy to open new scenarios and new perspectives it is necessary that people that have very different cultural backgrounds get dialogue among them.

This process is difficult because the majority of mankind haven't a scientific or technical bases which could allow to understand the deep sense of the entities under examination. Therefore, for them, it is hard to understand or analyzing phenomena difficultly understandable as electric ones for which the human body hasn't efficacious biological sensors. This lack of sensibility is then translated in indifference attitude for this entity.

To interpret the electric energy is necessary to provide parameters that synthesize it and that are share and understood by the most of people.

In this direction the power quality (PQ) quantitative parameters[1,2], typical of the normative, which describe the quality of the energy, can be supported by qualitative parameters, obtained by researches on the perceived power quality (PPQ) of electrical energy [3,4,5,6,7,8] with the declared objective to integrate the real exigencies of the production with the more aseptic normative parameters.

II. The Way

It is necessary to outline a course of action that allows to overcome the historical incommunicability [3,4,5,8] between the producers and the customers trying to balance a situation at present strongly favorable to the firsts.

The procedure, that at "Roma Tre University" they are following since five years ago, is based on three points:

a) the research of the real expectations of the customers joined with the electrical energy, determining the PPQ parameters;
b) realization both of new instrumentation with high metrological value and new instrumentation with high performances/costs ratio able to measure in real time the normed PQ parameters;
c) the same instrumentation should match PQ and PPQ parameters in real time to provide a new instrument to build new producer-customers electrical energy agreement typologies based on the quality of the energy.

A. The Expectations Researches

The researches try to understand what the customers want from the electrical energy and they born from practical experiences and from the observation of the real world.

We used two different approaches for different targets: little and medium enterprises (LME)[4,5,6,7] and low voltage customers (LVC)[8].

In both cases the first problem is to find a common language that realize a "linguistic bridge" between the customers and academic lexicon. To obtain it, the collaboration of electric operators (EO), that constantly work on the electric plants of the customers and so know their real electrical problems and needs and far from the Academy, has been fundamental.

In both cases we proposed a questionnaire to the customers but conceived starting from different assumptions. In the first case, the bad quality of electrical energy can often produced significant damages to the electric and electronic equipments as well as in terms of lost of productivity, so the endurance level is very low. In this case we thought that, to provide a good questionnaire, was necessary to try to understand which were the most significant problems signaled by the customers asking to well educated EO, able to understand the Academy language and contemporaneously knower of the LME electrical problems and needs, to prepare a list of questions on perceived power quality. The lists is been furnished to a restricted numbers of EO asking them to suggest their personal experiences in terms of "job lexicon".

By means of Academy supervision the combination between the two previous steps permitted to determine a "Pertaining to the Technology of Commerce Filter" able to establishes the correct languages to use in the questionnaire to arrive directly to the customers electric knowledge.

The questionnaire supplying in a restricted area (the Rome area), permitted us to determine the worst and the best electrical energy geographic points so allowing to define the perceived power quality fluxes the global signatures for the PPQ[4,5].

A different strategy has been adopted for LVCs. The consideration that everybody is a LVC, guided us in this research: everybody can have a own idea about electrical energy and its implications so everyone can freely express own impressions on it. So through few simple questions, we verified to qualified engineering students, to express their knowledge

about the electrical energy. Their answers clearly show how, also for them, that should be well prepared, the concept of electrical energy is faint! Basing on this assumption we divided the questionnaire in two parts the first part wants verify the electric energy knowledge level of a common LVC, the second part wants to verify which kinds of electrical problems they encountered and their endurance level for each problem.

Only for this second part the contribute of well prepared and not EO has been used. For this second part, as for the previous LME test, the questions are expressed in terms of failures.

Both researches anyway demonstrates the poor knowledge of the electric energy, the remarkable number of electric problems that the customers record during they workday or home life, the sense of impotence when a problem happens and, above all, the no ability to quantify the problems to express their owns needs.

B. The Instrumentation

The only way to try to solve this last problem is to effect measurements of the PQ normed parameters. To obtain these parameters are necessary instruments able to measure them possibly in real time.

A new instrument it has been developed for this aim (Fig 1) [3,4,5,6,7].

The hardware is based on a personal computer that have inside an acquisition card with eight channels, four connected to voltage sensors and four connected to current sensors. The firsts are voltage dividers able to partition the input voltage to preserve the analog input stage of the acquisition card channel. The maximum input voltage will be 6000 V as required by the normative. The current sensors are Rogowski coils that give an output signals proportional to the derivative of the measured current. This implies that it is necessary to integrate their output before to pass them to the acquisition card. The choice of this type of sensor, compared with others as amperometric clamp or current transformer, assures that the harmonic content would be unaltered. This aspect is fundamental to satisfy the harmonic analysis as required by normative. The accuracy of these sensors is ± 1%. By these eight sensors, the probe is able to pick up voltage and currents of the four phases (R,S,T,N) of an electric net.

One of the most important problem in case of civil suit, it is to determine more accurately possible the time of the fault. So it will be desirable that the synchronisms of the instrument, and particularly, of the sampling, were linked to the National Time Standard. At the present, the four active probes gets the synchronism directly by I.N.RI.M the Italian Metrological National Institute. The instruments are inserted in particular structures, the Medium/Low voltage transformer room of Telecom, the most important Italian telecommunication company, that receives the time directly from the I.N.RI.M.

To make independent the probes by the Telecom synchronism, we are studying the possibility to connect them with the GPS system. We are investigating the possibility to realize a new time reference constantly locked to the Caesium-derived GPS satellites carriers by means of a new GPS receiver architecture able to lock the two GPS carriers and mix them to obtain a reference frequency with an accuracy close to the GPS one.

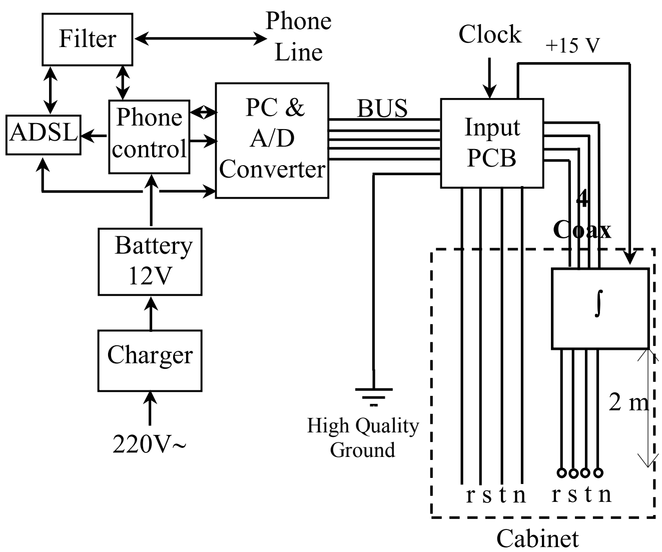

Figure 1. Block diagram of a PQ probe.

The software must be thought to satisfy the exigency to have the system under control in real time; this both for legal reasons and to reduce as soon as possible the intervention time in case of malfunctions. To respect as much as possible this constraint the FFT algorithm is not suitable [3,4,5,6,7,9], while the Curve-Fitting Algorithm, if appropriately modified, offers high accuracy performances producing results in real time[3,9,10]. At the present the program, that run in the probes, is able to determine the frequency of the fundamental with only three periods with an accuracy of 2‰. The program is then able to give al the PQ parameters required by the norms, quantifying, e.g., amplitude and frequency of the fundamental and its harmonics up to the 24^{th}, short and long interruptions, voltage dips, supply voltage unbalance etc..

Another software problem is the accumulation of the enormous data quantity. Also this is an opened problem because the probe transforms the acquired samples in synthesized PQ parameters every 5 seconds and store them in the hard-disk: every day is represented by about 5Mbytes of data.

It is clear that to accumulate, to transfer and to analyze this data quantity multiplied for *n*-possible sites during a large time could be extremely hard. A possibility to solve this problem could be to send the data to a central server with a very large memory capacity and able to further synthesize the PQ parameters, e.g., recording only the normative limits overcoming.

Another problem for this kind of instrument is the cost that could be unsustainable for LVC. To overcome this problem the previous research on the electrical energy real expectations for this kind of consumer is fundamental to understand which aspects of the power quality can be neglected. This approach is useful to plan a cheaper instrument, which can equally provide the measurements really interesting for the customers.

A series of these devices will be designed in the next future.

C. The Matching

Fixing PPQ parameters, measuring the PQ ones, their matching could seem a mechanic operation, but also for this, it is possible to work on different planes joined with the kind of customers.

The LMEs can be completely different to each other: they need energy for very different applications and with their energy use they can be protagonist in the production of energy "pollution" on the net. Instead LVC, and in particular the domestic customers, are very similar. Their low power energy request will be unlikely able to create significant problems to the electric net.

A first analysis could effect an electric energy quality local balance evaluating by quality fluxes for each quality parameters under study. Whereas on the one hand this analysis safeguards the users verifying that the energy bought has really the wished characteristics, on the other hand the measurements help the costumers to understand that their specific uses of the energy could be cause of undesirable "pollution" that could be transmitted to other users connected on the same electric network.

Conventionally we consider the instrument as the analysis point of view; if it record an harmonic distortion generated by the producer, it is taken with positive sign otherwise if the probe record that the harmonic distortion is generated by the customer, the pollution sign is taken negative.

A balance of the recorded parameters signs under control could be the base of an electric energy producer-customer agreement that could consider the energy quality an its essential component.

A most general analysis could allow to study also the quality parameter's fluxes and gradients to establish which zone of the geographic area under control produces more "pollution".

Following this approach it should be thinkable a kind of supply contract that could be extended to whole geographic zone. This analysis could take in consideration both the power consumption of the single user and the electric influence exerted by the zone on the others and vice versa.

III. Conclusions and Perspectives

The Perceived Power Quality suggest a different point of view in the analysis of electric energy problems; it asks to integrate the power quality research with a new element: the human electrical energy needs and expectations.

First of all, it suggests to study these needs and propose to find a common language between worlds completely different as producer and customers so trying to create a cultural bridge that could help these last to understand better this entity.

Only with the constant growth of costumer's Knowledge in this field it is possible allow them to quantify more and more precisely this entity and it will be possible to warrant their electric energy necessities.

In this approach a fundamental role could be expressed by independent research institute, as University, that could collaborate with the control Authority for the Electrical Energy to sustain before cultural policies to diffuse the Knowledge and then, to establish new type of relationships between customers and producers which lead to supply contracts that consider the quality an essential constituent element.

Surely the most important aspects, described in the article, point out the "road map" to diffuse the electric energy culture among customers, but large efforts have to be still done.

First of all, more researches must be done to define more and more accurately the real customers needs and necessities and, by the analysis of the customers feedback, trying to define the PPQ parameter and their relations with PQ ones with high accuracy.

It needs to develop instruments suitable for these necessities and able to satisfy different commercial targets.

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Contribution to establishing educational value of Optimization techniques laboratory

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***Abstract*-The article describes the contents of the laboratory that is a part of the course *Optimization techniques.* The two main topics are presented: the implementation of simple decent direction methods and the application of MATLAB Optimization Toolbox**

I. Introduction

The aims of the course *Optimization techniques* are ability of optimization algorithms implementation for constrained and unconstrained problems and skills of standard procedures applications. Appropriate organization of the laboratory is crucial to guarantee high educational values. The paper presents contribution based on experiences in organizing the courses. The first part of the laboratory exercises is devoted to the simple numerical methods of solving optimization problems like Steepest descent. The exercises enable to understand how these method works. The second part of the laboratory exercises is devoted to solving optimization problems using MATLAB Optimization Toolbox as the example of an optimization software.

II. Implementation of decent direction methods

It is possible to solve optimization problems by directly using the optimality conditions [1]. However, setting up and solving the resulting nonlinear system of equations becomes very difficult as the problem size increases. The numerically oriented methods are suitable for practical optimization problems. The decent direction methods are fairly well developed. Of course , the numerical methods are designed to find a local minimum point and there is no guarantee that a solution returned by these method is a global minimum.

The problem is stated as follows [1]:

Find a vector of optimization variables $\boldsymbol{x}$ *that minimizes* $F(\boldsymbol{x})$

The basic iteration for all decent direction methods can be written as follows

$$\boldsymbol{x}^{k+1} = \boldsymbol{x}^k + \alpha^k \boldsymbol{d}^k \quad k=0,1,\ldots.$$

Where $\boldsymbol{d}^k$ is known as the descent direction, and α^k is a scalar known as the step length.

Those methods seeks the solution in subsequent steps. We have to define the starting point $\boldsymbol{x}^0$ - usually chosen arbitrarily. At each iteration a descent direction and a step length should be chosen such that $F(\boldsymbol{x}^{k+1}) \le F(\boldsymbol{x}^k)$ Once a descent direction is known, the problem of computing an appropriate step length is usually reduced to finding the minimum of function F in the direction $\boldsymbol{d}^k$ .The problem is stated as:

Find a value of α *minimizing* $\Phi(\alpha) = F\left(\boldsymbol{x}^k + \alpha \boldsymbol{d}^k\right)$

There are several methods for determining the descent direction. The most popular methods include Steepest descent, Conjugate gradient, Modified Newton, Quasi-Newton. The iteration is stopped when suitable convergence criteria is satisfied. An example of a typical exercise, that enable to understand how the decent direction method works is given below:

Problem 1

Given is a two dimensional function

$$F(\boldsymbol{x}) = 5x_1^2 + x_2^2 - 2x_1x_2 - 8x_1$$

Find the minimum point using steepest decent algorithm, defined as

$$\boldsymbol{x}^{k+1} = \boldsymbol{x}^k + \alpha^k \boldsymbol{d}^k$$

where $\boldsymbol{d}^k = -\nabla F(\boldsymbol{x}^k)$ is the search direction and α^k is the variable step length.

Start at $\boldsymbol{x}^0$=[3;4]. α^k is estimated in each step searching the minimum of the function F in the point $\boldsymbol{x}^k$ and the direction. $\boldsymbol{d}^k$

An example of a short MATLAB program that can solve the problem is listed below:

```
x=[3;4];
wt=[0:0.001:2];
for k=1:10
d(:,k)=-[10*x(1,k)-2*x(2,k)-8;
2*x(2,k)-2*x(1,k)];
xd=[x(1,k)+wt*d(1,k);x(2,k)+wt*d(2,k)];
wfcd=5*xd(1,:).^2+xd(2,:).^2-
2*xd(1,:).*xd(2,:)-8*xd(1,:);
[a,b]=min(wfcd);
t(k)=wt(b);
x(:,k+1)=x(:,k)+t(k)*d(:,k);
end
  plot(x(1,:),x(2,:),'o--')
```

Fig. 1 shows the results of running the program. It generates – in each iteration - the points (x_1, x_2) that are the consecutive approximations of the minimum point . It can be noticed, that the algorithm converge to the point (1,1) – which is the minimum point of $F(\boldsymbol{x})$.

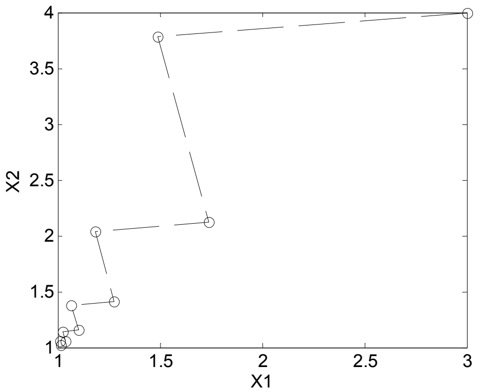

Figure 1. The results generated by the steepest decent algorithm

The next example concern the other popular decent direction method – the Conjugate gradient:

Problem 2
Given is a two dimensional function
$F(\boldsymbol{x}) = 5x_1^2 + x_2^2 - 2x_1 x_2 - 8x_1$
Find the minimum point using conjugate gradients algorithm, defined as

$$\boldsymbol{x}^{k+1} = \boldsymbol{x}^k + \alpha^k \boldsymbol{d}^k$$

where $\boldsymbol{d}^k = -\nabla F(\boldsymbol{x}^k) + \beta^k \boldsymbol{d}^{k-1}$ is the search direction and α^k is the variable step length. The coefficient β is defined $\beta^k = \left\|\nabla F(\boldsymbol{x}^k)\right\|^2 / \left\|\nabla F(\boldsymbol{x}^{k-1})\right\|^2$

Start at $\boldsymbol{x}^0$ =[3;4]. α^k is estimated in each step searching the minimum of the function F in the point $\boldsymbol{x}^k$ and the direction. $\boldsymbol{d}^k$

The results generated by the conjugate gradients algorithm are shown in Fig. 2.

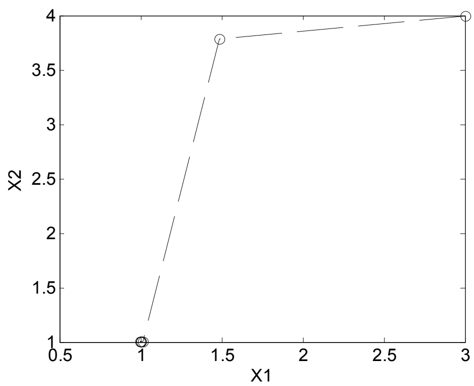

Figure 2. The results generated by the conjugate gradients algorithm

It can be noticed that the conjugate gradient algorithm acts in this case much faster than the steepest decent algorithm.

III. APPLICATION OF MATLAB OPTIMIZATION TOOLBOX

The Optimization Toolbox is a collection of functions that extend the capability of the MATLAB numeric computing environment [2]. The toolbox includes routines for many types of optimization including unconstrained nonlinear optimization, constrained nonlinear optimization, linear and quadratic programming, nonlinear least squares, nonlinear system of equations solving. All the toolbox functions are MATLAB M-files made up of MATLAB statements that implement specialized optimization algorithms

A simple example of a problem solved using the Optimization Toolbox is given below. The same objective function as in *Problem 1* and *2* is used.

Problem 3
Minimize $F(\boldsymbol{x}) = 5x_1^2 + x_2^2 - 2x_1 x_2 - 8x_1$

The solution involves two steps:
Step 1:write an M-file objfun.m:

```
function f=objfun(x)
f=5*x(1).^2+x(2).^2-2*x(1).*x(2)-8*x(1);
```

Step 2: Invoke the unconstrained optimization routine:

```
x0=[3,4];
options=optimset('LargeScale','off');
x=fminunc(@objfun,x0,options);
```

This produces the solution:

x =

1.0000 1.0000

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Studying in an International Environment: Example “Neisse University”

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7th EEEIC Conference
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May 5th – 10th, 2008

Abstract: The goal of this paper is to introduce to the reader an example of studying in an international and multicultural environment. It will nearer examine how the studies have been experienced by the author at Neisse University. Furthermore some selected aspects of cultural differences and international integration will be discussed.

I. Introduction

The so-called Neisse University is not a really existing university as one might understand in common sense but an artificial network between three universities – the Technical University Liberec (Czech Republic), the Technical University Wrocław (Poland) and the University of Applied Sciences Zittau/Görlitz (Germany).

There are existing two accredited study courses at the moment: the Bachelor course *Information and Communication Management* and the Master course *Environment Health and Safety Risk Management*. For this concept of international studies is unique in Europe, these courses are strongly supported by the European Union.

All courses are hold in English, except the national language courses. The Bachelor course has a strong focus on subjects from computer science (50%) and subjects from the field of business studies (30%). The remaining 20% are made up of psychological aspects, cultural issues and national language courses.

At most 30 students (ten from each country) are enrolled per year. In 2004 25 students were enrolled (ten from Poland, eight from Germany and seven from Czech Republic) from which 14 students graduated by July 13th, 2007.

Figure 1. Official logo

II. Integration Of Czechs, Poles And Germans

A. Language Barrier

The main thing preventing full integration between all students is the different level of language skills since for all of them English is a foreign language. Therefore the students are not always able to express themselves as they could do in their native language. On the other hand the students definitely improved their communication skills by learning to describe without looking up every word in a dictionary.

It has to be noticed that there are much bigger barriers between Germans and Czechs/Poles than between Czechs and Poles. The reason for this is that latter ones have similar language roots so that there were nearly no problems in understanding each other although they have never learnt any Czech respectively Polish. Therefore in the beginning there have been two separated groups: on the one hand the Czechs and Poles and on the other hand the Germans.

For full integration it is necessary to find a way of communication that each participant can cope with. It has to be ensured that each member of the group is able to understand the common language in an adequate level in order to not to be excluded by the group. Actually that is the basic rule but alarmingly often it is just neglected or at least underestimated. It could be seen that people fell back to their native language and therefore excluded the others who do not have that high level of language knowledge than the others.

B. Initiation

From the very start could be observed that many people were shyly observing each other and waiting for the other’s initiative. Being cosmopolitan but still having some deadlocked prejudices in mind, in particular Germans had initially a somewhat reserved and sceptical attitude but it has not been distrust.

The excitements, amazement, all questions, future parties etc. of what the future will bring were much stronger than all skeptics.

But: Without initiating and forcing the integration process nothing will be achieved since it cannot run on its own. The initiation is a result of people’s willingness and curiosity of making relationships, finding new friends and exploring unknown cultures and mentalities.

C. Living Together

In order to overcome those barriers all of the students tried to learn the native languages of the others. They studied it in language courses offered by the universities and on private base as for example on some cultural evenings with cooking typical meals, celebrating special holidays and talking in general about specific habits and customs.

This also fostered the relationships between the students. After a short period of time deep friendships developed that even last until today. The students were celebrating almost every day – no matter if there was a reason or not.

They have also joined sports clubs or went to so-called regulars' tables where for example all foreign students met once a week. So they also got to know people from outside our studies and also from other countries as e. g. Turkey, Austria, Hungary and so on.

III. Experienced Cultural Differences

In the past years we always heard in the media about globalisation, EU East Expansion and integration of foreigners. On May 1st, 2004 among other states Poland and the Czech Republic became members of the European Union and since December 21st, 2007 there are not existing formal borders any longer.

For Neisse students who are lucky to study for one year each in Poland and Czech Republic these words are not just simple phrases. In their everyday life the students were faced the real meanings of those terms. All students originally come from Saxony or Brandenburg, Northern Bohemia and Southern Silesia, willing to study and live in a multicultural environment.

For studying abroad it is necessary to understand the differences between foreign cultures. So first people have to get to know about the cultures and mentalities and in the next step they need to accept them. Without accepting it is impossible to understand the opponent's behaviour and this might be understood as intolerance or ignorance which could be in turn experienced as offending.

In the beginning of the studies it could be seen that everybody was curiously observing each other. Of course there have been some prejudices. Each student had a picture of a typical German or typical Pole in mind. Some of those clichés proved true, other ones were disproven and changed the picture mostly in a positive way.

During the course of time the trust among each other raised amazingly and most of the barriers in mind were crashed down. Foreigners became close friends up to now or even international couples. That fact shows that the integration between these three nations was successful.

In general can be said that the Czech and Polish mentalities are more similar in comparison to the Germans. Both of them are very friendly and open-minded while Germans are slightly more reserved which became over the course of time less and less.

All by the author experienced differences and similarities of character traits can be summarized as listed in the table below. Self-evidently the table is not complete and just a selection of the main characteristics.

TABLE I
Typical Character Traits

Czechs	Poles	Germans
• unpunctual	• unpunctual	• punctual
• hospitable	• hospitable	• diligent
• open-minded	• open-minded	• busy
• tolerant	• tolerant	• reliable
• interpersonal	• frank	• ambitious
• reliable	• interpersonal	• perfectionist
• diligent	• lazy	• creative
• ambitious	• relaxed	• serious
• making efforts	• flexible	• inflexible
• interested	• good-humoured	• disciplined
• warm	• helpful	• sceptical
• responsible	• deeply religious	

IV. Conflict Potentials

The highest conflict potentials between Germans and Czechs/Poles were the attitudes towards time (Czechs and Poles were mostly late) and the level of reliability which was sometimes quite a hard problem to be solved. As seen in the table Poles have the tendency to be very relaxed and lazy while Germans hold the view on always being in time. Germans are also very busy, disciplined and serious which makes them somehow inflexible. Czechs and Poles disliked the pushy German way of working. Furthermore can be noticed that Germans have an addiction to be perfectionist while Poles are more inaccurate and do not more than expected or necessary. The Czech students mostly chose a way between.

V. Conclusions and Summary

In retrospect on those three years is to be said that studying in an international and intercultural environment is an excellent means to have a look beyond one's own nose.

After fighting first initial difficulties the whole study group of 25 students became close friends or even couples in just a few months. Everybody is still in contact with each other which is an evidence of full and successful integration.

Each personality has changed during the last years. Conflicts were managed in a professional way without having great struggles but objectively discussing the facts and finding compromises. Neisse University teaches people to find one's feet and to deal with cultures different from their own one. Beyond doubt it increases interpersonal as well as intercultural communication skills and it fosters values such as tolerance and humanity. Last but not least is to remark that it makes people also thinking about their own culture and changes them.

References

For this paper is based on own personal experiences and knowledge gained over the past three years, there are not existing any references.

Danzig the city of changes

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The free town of Danzig is a former „Hansa“ city in the north of Poland and west of the Weichsel delta. The city has about 450,000 inhabitants and an area of about 262.2 square kilometres. The city forms with Gdingen and Zoppot the population centre called “Dreistadt” with a population of 1.2 million

The 1010 years old history of Danzig

In the area of Danzig was populated from 50 before Christ to 600 after Chr. by a settlement of the “Goten” whose population mixed in the 5th to 9th century with slawish and prussian tribes.

In the year 997 the missionary Adalbert of Prag was visiting that area and was the first to historically mention the name Danzig, that was 1010 years ago. In 1184 the monastery of the „Zisterzienser“ order was founded and brought German traders and craftsman into the area. That allowed Danzig to be granted the “Lübic” city right and thereafter the “Kulmer” city right. The successful city was converted to a „Hansestadt“, the German trade union of cities, in 1361.

In the 15th century Danzig became a free city republic. The city grew fast through the acquired wealth and architectural pieces and buildings were constructed. The population grew to 80.000 until the year 1650.

After the second parting of Poland in 1793 Danzig became a part of “Preußen”. In 1807 the city was besieged by Prussian Sachsonian and French troops but became a free city again through the “Tilsiter” peace treaty. During the French reign between 1807 and 1814 the city was exploited and the population decreased to 16.000 inhabitants. That changed by the treaty during the “Wiener” congress in 1815 where Danzig was assigned to “Preußen” again. With the establishment of the “German Reich” under the leadership of Preußen Danzig became a part of the “Reich” as well.

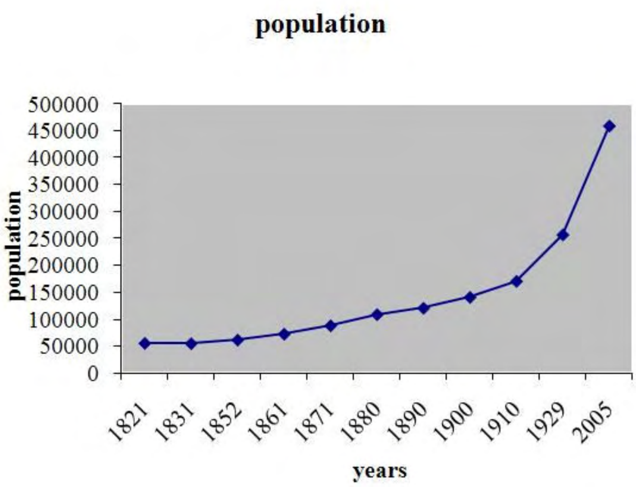
After 1871 the city developed to become the centre of industrialisation and modern ship crafting in the west of Preußen.

In 1904 the Technology University of Danzig was founded. After the first world war the city was assigned an exceptional status by the “Versailler” treaty and stayed free and watched by the union of countries. Economically Danzig was treated as a part of Poland.

Then the second world war started on the 1st of September in 1939 through the shooting of the ship ”Schleswig Holstein” and Danzig became once again German territory. The city was even made regional capital of “West Preußen”. At the end of the war the city was severely damaged. After the “Potsdamer” treaties Danzig became a part of Poland.

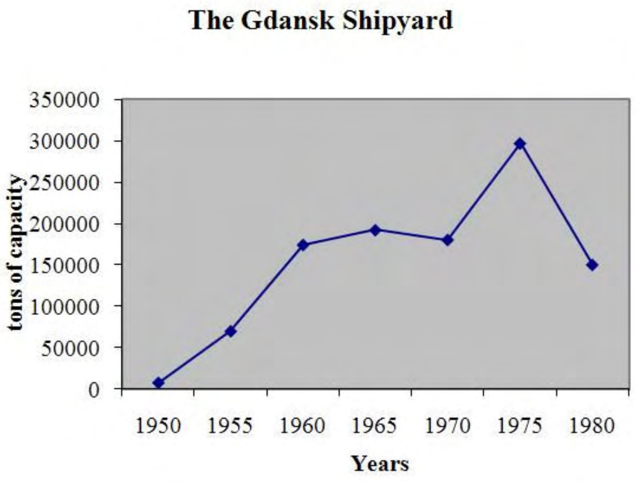
During communist times the city was an important trade and ship construction centre. In 1980 the revolutionary strikes by ship construction workers, under the leadership of the trade union “ Solidarnosc”, were started in Danzig by Lech Walesa, their leader. These activities were the source of the political change in the whole East block and caused in 1990 the political change in Poland

Thereafter a period of extensive social and economic changes started and is still going on. The population statistics during that period is shown in the graph below and caused by the constantly positive developing economy.



Economy

From an economic point of view the city is well placed at the East Sea and because of that on of the most important economic activities is still the transport of goods, with a container conversion of 23.3 Million tones. Further important economic cornerstones are the construction of ships, with Gdansk Shipyard and Northern Shipyard and the petrochemical industry with Dr. Oetker and PepsiCo. Recently High-tech industries started to settle down in Danzig as well, with Intel and Young Digital Poland. The tourism industry is growing as well and increasingly important for the region. To further enhance the settlement of economic and technologic companies different incentive programs were created and partly financed by the European Union.



Transport

Danzig has a good railway connection to many polish cities and Europe, with direct trains to Kaliniengrad and Berlin. Furthermore the city has a well developed tram system that connects the centre with the outlying towns Zoppot and Gdingen.. Inner city traffic consists of trams and bus lines. The airport of Danzig is used by 1.2 Million passengers per year and different airlines like Lufthansa, SAS and Ryan Air fly to and from Danzig.

Ferry connections exist to Sweden and Denmark. The “A1” highways project is supposed to be finished by 2013 and will connect Danzig with Middle and South Poland.

Sightseeing

Danzig offers more than 1000 years of culture and the city consists of buildings constructed in many different centuries. It is very rich in monuments. Some of the most important are the catholic “Marien” church, the “Zeughaus”, the Neptun well and the “long market”. The Marien church was constructed between 1343 and 1502 and is the biggest church made out of brick world wide. 250.000 people fit into the building.
The Neptun well was build to honour the god of the sea and was moved to the “Artus” yard in 1633.

Education

10 Universities can be found in Danzig with about 60.000 students coming from different nations where of 10.000 finish there studies successfully per year.
One of the most important Universities of the port town is the University of Danzig which was founded in 1970. The University was created through the merger of the economic University of Soppot and the social University of Danzig, which was founded in 1946. 30.000 students study currently at the University of Danzig in 26 courses of study.
A second important University is the technologic University of Danzig which was founded in 1904 and accounts for 18.000 students. Four other Universities are the medical academy, the sport school of Danzig, the music academy and the academy of arts

Important people of Danzig

Danzig was home to important personalities throughout all centuries like Günther Grass, Daniel Gabriel Fahrenheit, Arthur Schoppenhauer, Donald Tusk, Lech Walesa, Daniel Nikolaus Chodowiecki, Dariusz Michalczewski und Johannes Hevelius.

Günter Grass (* 16. Oktober 1927 in Danzig-Langfuhr) is a german writer, artist, painter and graphic designer with kashubic ancestors and was a member of the group „47“. He is considered on of the most important German writers of the presence. In 1999 he was awarded the Nobel price for literature.

Daniel Gabriel Fahrenheit (oder *Gabriel Daniel Fahrenheit*) (* 24. Mai 1686 in Danzig, † 16. September 1736 in Den Haag)
was a German physic and inventor of measurement instruments. The unit to measure temperature was given his name.

Arthur Schopenhauer (* 22. Februar 1788 in Danzig; † 21. September 1860 in Frankfurt/ Main) was one of the first in the 19th century to proclaim that the world is based on an irrational concept.

Donald Franciszek Tusk; * 22. April 1957 in Danzig) is a liberal polish politician and since 2007 prime minister of Poland. Furthermore he is co-founder and leader of the liberal-conservative party “Platforma Obywatelska” (PO, eng. Platform of the people).

Lech Wałęsa * 29. September 1943 in Popowo**)** was a simple electric worker at the Lenin ship construction site before he became strike leader, peace nobel price winner and president of Poland.

Daniel Nikolaus Chodowiecki was born on the 16th of October 1726 in Danzig as son of a polish weed merchant. He was a popular painter and copper artist, before he became director of the Berlin academy of beautiful arts.

Dariusz Michalczewski (* 5. Mai 1968 in Danzig) is a former German-polish boxer who was from 1994 to 2003 world champion of the WBO. Because of his offensive boxing stile he became known in Germany as the “Tiger”. During his 12 year long boxing career he was never defeated.

Johannes Hevelius (spelled according to his writings in Latin,.
in German *Johannes Hevel* or *Johann Hewelcke*, polish *Jan Heweliusz*; * 28. Januar 1611 in Danzig; † 28. Januaryy 1687 Danzig) was a protestant astronomer and is said to be the founder of the cartography of the moon.

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EU-China
Closer partner, growing responsibilities

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I. INTRODUCTION

China, an ancient, mysterious and beautiful land, is always appealing to adventurous foreign visitors. Its long, rich history is one of his greatest treasures. China has its own political system different from that of the west countries. It is a nation cultured by Taoism, Confucianism and Buddhism for 5000 years. At the same time, China has also re-emerged as a major power in the last decade. It has become the world's fourth economy and third exporter, but also an increasingly important political power. Meanwhile, china faces also a range of challenges, such as energy problems, environment pollutions, and social issues.

The EU offers the largest market in the world. It enjoys world leadership in key technologies and skills. The EU plays a central role in finding sustainable solutions to today's challenges, on the environment, on energy, and on globalization.

China and EU stand for the typical east and west differences like culture, but also have the common interests in many fields. To better reflect the importance of their relations, the EU and China agreed a strategic partnership in 2003. It is to everyone's benefit that a good China-EU relation must be maintained. Now China is, with the EU, closely bound to the globalization process and becoming more integrated into the international system.

II. THE WAY FORWARD

As the partnership strengthens, expectations and responsibilities on both sides increase. As China's biggest trading partner, EU trade policy has an important impact on China, as do China's policies on the EU. The EU and China benefit from globalization and share common interests in its success. It presents challenges to both and brings further responsibilities. Increasingly, both sides expect that impact to be taken into account in their partner's policy formulation.

A. China's transition towards more open and plural society

The Chinese leadership has repeatedly stated its support for reform, including on basic rights and freedoms. Most of the European people sincerely wish to see China to become a more free and democratic country. In this process, The EU can offer C China experiences and information, which could make contribution to china's reform. But based on that, we Chinese should free to choose our own destination and progress in the pace that we feel comfortable with, and we should also recognize the culture differences among nations. Democracy, human rights and the promotion of common values remain fundamental tenets between China and the EU. The development of a full, healthy and independent civil society is not only beneficial to China, but also essential for the interests of the EU.

B. Ensure secure and sustainable energy supplies

One of today's key global challenges is to ensure our development is sustainable. China will be central to meeting this challenge. As important players in world energy markets, the EU and China share a common interest and responsibility in ensuring the security and sustainability of energy supplies, improving efficiency and mitigating the environmental impact of energy production and consumption. In this process, the EU has the most advanced technologies which can be offered to help China to strengthen China's technical and regulatory expertise, reduce growth in energy demand, increase energy efficiency and use of clean renewable energy such as wind, biomass and bio fuels, promote energy standards and savings through the development and deployment of near zero emission coal technology.

Besides, Wastes both those produced and those avoided, are a major concern in any consideration of sustainable development. We should make sure that this planet is forever fit for the human habitation.

C. Combat climate change and improve the environment

China has become the world's second biggest energy consumer. This is not only because of the dramatic economic growth and energy consumption, but also the inefficient use of different kinds of resources. Climate is the context for life on earth. Global climate change and the ripples of that change will affect every aspect of life. And in the industrial society CO_2 is the most important reason for the climate change. China and the EU together account for around 30% of global energy consumption and 30% of global emissions.

The EU should share regulatory expertise, working with China to prevent pollution, safeguard biodiversity, and make the use of energy, water and raw materials more efficient. Their common interests provide a foundation for deepening collaborative efforts on energy and climate security.

D. *Trade and economic relations*

China's integration into the global trading system has benefited both Europe and China. The EU is China's largest trading partner, representing more than 19% of China's external trade, while for the EU China is second only to the United States. The EU can support China's social and economic reform process that is transforming Chinese lives and livelihoods, and help China integrate into the world economy. European companies trading with and investing in China have contributed to China's growth, bringing capital goods, knowledge and technology that have been instrumental to China's development. At the same time, a more open China can offer EU a larger market for the European products, and the products "made in China" can lower the price for the European consumers. A very conflicted problem in the economical field is that the imports and exports are not balanced and the difference becomes larger year by year since 2000. But under the negotiation between two sides, this problem can also be resolved effectively.

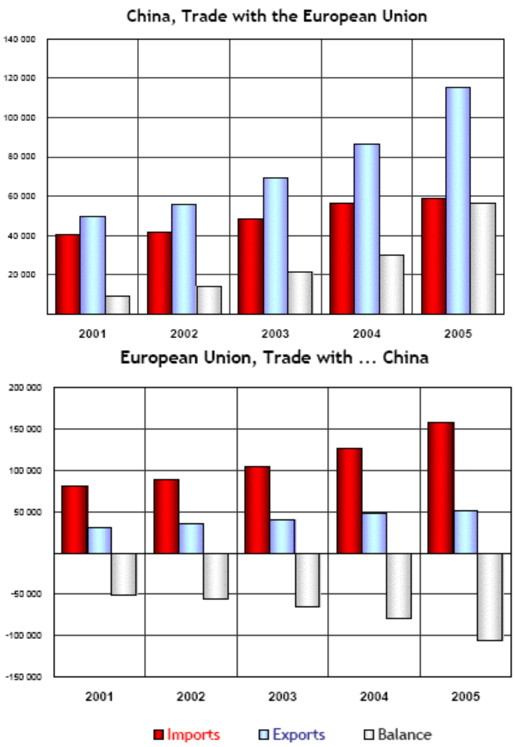

Figure: Trade between China and the EU

E. *Improve coordination on international development*

Closer cooperation on international development issues would benefit the EU, China and other partners. There are significant downsides if we are not able to coordinate effectively, particularly in the field of international issues such as North Korea nuclear problem and so on.

F. *Expand people- to- people links*

We should strengthen the full range of people-to-people links which underpin our relations through significant and sustained action on both sides, from cultural exchanges and tourism to civil society and academic links. Education has been an area of particular success, with 170 000 Chinese students studying in the EU in 2005. In this way the Chinese students can understand more European culture, meanwhile, the EU should also encourage the European students to study in China to understand the Chinese history, culture and also China's potential to be an economical and political power all around the world.

III. CONCLUSION

China is one of the EU's most important partners. China's re-emergence is a welcome phenomenon. We have a strong and growing bilateral relationship. And we must continue build on this. We should strengthen the full range of people-to-people links, especially in the field of the cultural exchange.

A closer, stronger strategic partnership is in the EU's and China's interests. But with this comes an increase in responsibilities to improve this relationship, to shape a better future for both sides.

ACKNOWLEDGMENT

For this paper we are really grateful to our friend Xiang, who gave us a lot of information about the environmental issues, which is useful to this paper.

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Geothermal power plants – future of Polish power engineering

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I. Introduction

In polish power engineering we mostly use coal power plants this appear from fact that we have a very big resources of this raw material. Unfortunately this sort of power plant have one big weakness – they heavy polluted natural environment and after year 1997, when was a Kioto conference and where we have sing the protocol and undertaken that we will reduce an emission of carbon dioxide to the air by 6%, we should search for other solutions. But Kioto protocol isn't the only cause that we must search for alternatives. For example the biggest power plant in Poland – Belchatow – that is feeding by brown coal from nearby quarry, have resources for only 25 years after that power plant will be useless. Of course geologists are looking for new deposits, in fact they fond it, but there are about 50 km from Belchatow ! How transport that number of cola for such distance or maybe we move power plant to new place but this is a huge enterprise and probably for only next 30-40 years and then what ? That are the questions which we have to handle in coming years. In Poland there are lots of people who see solution in nuclear power plant but this isn't the way. Why most UE countries have forbidden by law building new nuclear power plants ? Isn't that weird or maybe they have a reason to do this? Think about it. Someone says that nuclear power plant will bring to us energetic independence and safety but this isn't true because we don't have deposits of uranium so we must buy it from e.g. USA and there is also matter of toxic waste dump and of course such power plant will be great target for terrorist. So in the end probably the only right choice that left are renewable energy sources. This direction UE takes long time ago and also Poland should fallow this road. In fact UE law required from new joined nations to increase they participation in renewable energy sources to 7,7% in 2010 and to 14% in 2020 so we must do something in this direction anyway and geothermal energy could by one of the solutions.

II. Geothermal energy – what is it ?

The word geothermal comes from the Greek words geo (earth) and therme (heat). So, geothermal energy is heat from within the earth. We can use the steam and hot water produced inside the earth to heat buildings or generate electricity. Geothermal energy is a renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

III. Geothermal resources in Poland and Europe

First geothermal power plant has been built in Lardarello in Toscania, which one is working to today. In fact Italy is the biggest producer energy in Europe from geothermal resources and in 2003 they produce about 791MW, second one is Island 230MW where this is about 50% of all request for electric power . In Poland we have few heat and power station which total power is 82MW in 2004 this is very low result whereas we have the biggest resources in Europe, about 80% of territory can be use to build plants. This is three time more than Germany have. This appear from fact that Poland is on main axis "geothermal ditch" which one cross from Island, along Danish, north-east Germany, Poland, Ukraine, Black Sea to Turkey.

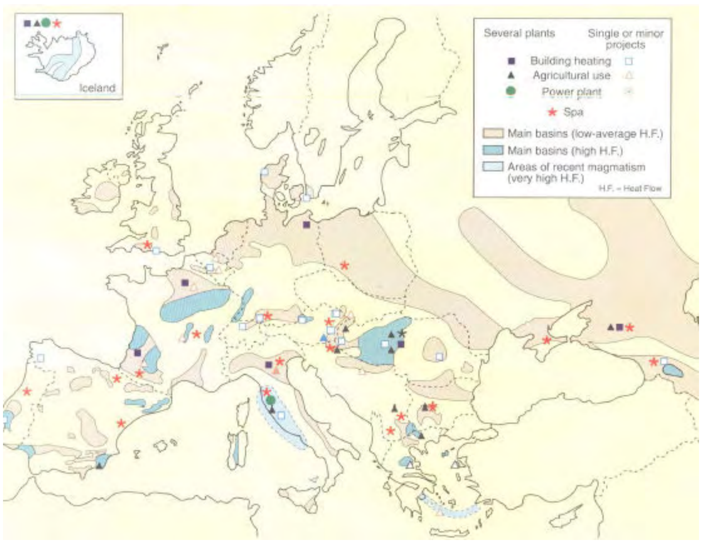

Figure 1. Geothermal energy resources in Europe.

IV. HOW GEOTHERMAL POWER PLANT WORKS ?

Geothermal power plants works similarly as classical steam plants, when temperature inside of earth exceeded 300°C; or with additional circuit with special medium when temperature is lower than 80-120 °C. This second one is called in world as ORC (Organic Rankine Cycle) geothermal power plant in which one has been used not classical water-stem scheme but others carrier of energy e.g. light hydrocarbons. They vapor warmth amount 15-17% vapor of water therefore we can use it at low temperature of geothermal liquid.

Shame of OCR type geothermal plant shows Figure. 2. There are three basics circuits in it: first geothermal (I) contain circuit of hot water flowed from deposit to heat exchanger from where cool water turning back to deposit. In second circuit (II) – thermo dynamical – is revolving boiling energy carrier. This is chemical matter which is use mostly in cooling industries. Third circuit (III) is cooling circuit and it have a task to equalize a heat of whole system by chimney-cooler.

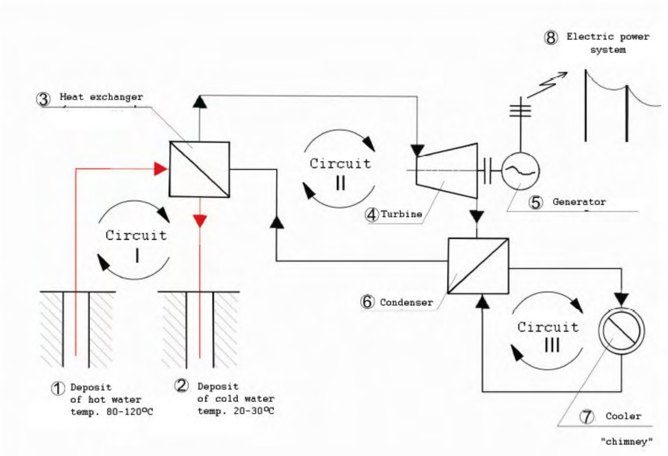

Figure 2. Scheme of ORC geothermal power plant.

First circuit (I) of power plant make tightly-closed flow of hot water from well bore to heat exchanger taking warmth of geothermal water from deposit and giving that heat through exchanger to circuit (II). Geothermal water after cooling turning back to deposit. In second circuit (II) collected heat on exchanger through organic warmth carrier cause vapor of this medium in low temperature 60-80°C which steam leaded to turbine blade, fixed it in rotational motion transferred to generator produced power. Generated current in geothermal power plant is transmitted to power system. Third circuit (III) have to cooled down temperature of work medium through condenser. To do this we use water, but she don't have direct connect with heat carrier working in circuit (II) of power plant. Cooling water could by prepare in similar way as in classical power plan with chimney-cooler.

Temperature of geothermal water, quantity in time, pressure and chemical composition mark basic parameters which we must include when we projecting geothermal power plant or heat and power station.

V. COST OF ELECTRICAL ENERGY AND HEAT FROM GEOTHERMAL STATION

Costs of production one unit of energy (kWh) from geothermal power plant is lowest in the world. In table below there is comparison of different renewable energy source based on official data from UE.

TABLE I. Production of electrical energy from renewable energy sources in Europe

	Electrical energy	Production in 2005		Total power in 2005		Today cost of energy	Future cost of energy	Investment cost
		TWh	%	GW	%	USc/kWh	USc/kWh	USc/kWh
1	Water	2600	92	663	92	2-10	2-8	1000-4000
2	Biomas	160	5,7	40	5,5	5-15	4-10	900-3000
3	Geothermal	46	1,6	8	1,1	2-10	1-8	800-3000
4	Wind	18	0,7	10	1,3	5-13	3-10	1100-1700
5	Sun	1,5	0,05	1,0	0,1	12-125	4-25	3000-10000
6	Tide energy	0,6	0,02	0,3	0	8-15	8-15	1700-2500

From presented above data appear that the biggest quantity of energy in 2005 year we obtain from hydro-electric power station (97%), biomasses (5,7%) and geothermal (1,6%). Especially promoted by European lobby wind energetic delivers only 0,7% and solar hardly 0,05%. On this ground geothermal energetic is last twice more effective than wind.

Actual cost of electrical energy produced from renewable energy sources also speak to geothermal energy. It is on the same level as hydro power plants and about 6 times cheaper than solar energy. Also building new power plants is not so expensive as in others instances.

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Power Swing Phenomena and its Detection and Prevention

Umar Naseem Khan and Lu Yan

***Abstract*—Power Swing which is basically caused by the large disturbances in the power system which if not blocked could cause wrong operation of the distance relay and can generates wrong or undesired tripping of the transmission line circuit breaker. And if not prevented from the generator could cause severe damage to the machine. To prevent unwanted distance or other relay operation during a Power Swing, we did fundamental studies of traditional and advanced detection and prevention methods. Further, we did research on setting of Power Swing Blocking (PSB) scheme to realize real applications.**

***Index Terms*—power system, power swing, detection, prevention, protective relay.**

I. Introduction

IN the past few years we have experienced big disturbances in the power system which caused complete blackout and million of users including industry have suffered big economical losses. These disturbances cause big oscillations in active and reactive power, low voltage, voltage instability and phase or angular instability between the generated and consumed power which results in loss of generation and load which effected both the power generation and the end customers.

During the steady state condition, power systems operate on the nominal frequency (50Hz or 60Hz). The complete synchronism of nominal frequency and voltage at the sending and receiving ends cause complete balance of active and reactive power between generated and consumed active and reactive powers. In steady state operating condition Frequency=Nominal frequency (50 or 60 Hz) +/– 0.02 Hz and Voltage=Nominal voltage +/– 5% [1].

Power system faults, line switching, generator disconnection, and the loss or application of large blocks of load result in sudden changes to electrical power, which is due to the causes shown in Fig. 1.

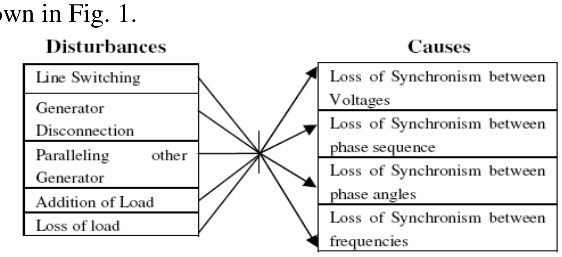

Figure 1. Causes due to different disturbances

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Whereas the mechanical power input to generators remains relatively constant.

The electrical power, P_g transferred from the generator, an electric machine, to the load is given by the equation:

$$P_g = \frac{E_g E_1}{X} \sin \delta \tag{1}$$

where:
E_g = Internal voltage and is proportional to the excitation current
E_l = Load Voltage
X = Reactance between the generator and the load
δ = Angle that the internal voltage leads the load voltage

$$P_a = P_m - P_g \tag{2}$$

P_m = Mechanical Turbine Power of the generating unit
P_g = Electromagnetic Power output of the generating unit
P_a = Accelerating Power

The mechanical power, P_m, is provided by the turbine and the average mechanical power must be equal to the average electrical power. When a system disturbance occurs there is a change in one of the parameters of the electrical power equation. For faults, typically the reactance between the generator and the load (X), the load voltage (El), or some combination of these two parameters causes the electrical power to change. For example, for a short circuit the load voltage is reduced, for a breaker opening the reactance increases. When a generation unit trips, the required electrical power from the remaining generators increases. In this case, the instantaneous mechanical power provided by the turbine is no longer equal to the instantaneous electrical power delivered or required by the load. When the load on a unit is suddenly increased, the energy furnished by the rotor results in a decrease in the rotor angular velocity [2]. And this decrease in rotor velocity will cause oscillations in rotor angle and can result in severe power flow swings.

A. Example: Generator disconnection due to fault

Suppose we have two generators G1&G2 in parallel, and both the generators are sharing load. On the sudden disconnection of G2, there will be an increase in load on G1 and due to this there will be the oscillations in the rotor angle of G1, which is represented in Fig. 2.

In Fig. 2, δ is the steady state rotor angle and δ’ is the change in rotor angle due to oscillations which will result in

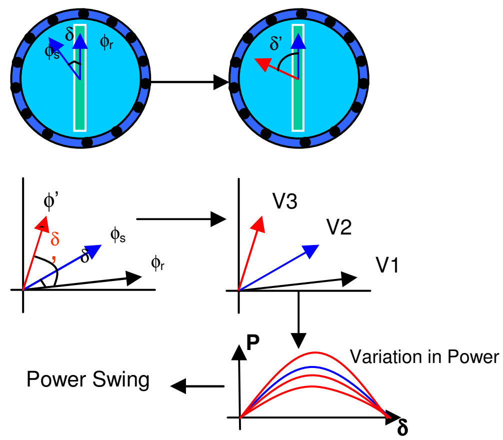

Figure 2. Representation of the power swing due to change in rotor.

the oscillation of nominal voltage, and this oscillation in the nominal voltage causes loss of synchronism between the generators in parallel or between the generation and load.

Depending on the severity of the disturbance and the actions of power system controls, the system may remain stable and return to a new equilibrium state experiencing what is referred to as a stable power swing. Severe system disturbances, on the other hand, could cause large separation of generator rotor angles, large swings of power flows, large fluctuations of voltages and currents, and eventual loss of synchronism between groups of generators or between neighboring utility systems [1]. Stable Power Swing: Small disturbances which can be control by the action of Power System and the system remain in its steady state condition. Unstable Power Swing: Severe disturbances can produce a large separation of System Generator Rotor angles, large swings of power flow, large fluctuations of voltages and currents, and eventually lead to lose synchronism.

B. Power Swing Effect on the Distance Relay

Power swings can cause the load impedance, which under steady state conditions is not within the relay's operating characteristic, to enter into the relay's operating characteristic, Fig 3. Operation of these relays during a power swing may cause undesired tripping of transmission lines or other power system elements, thereby weakening the system and possibly leading to cascading outages and the shutdown of major portions of the power system.

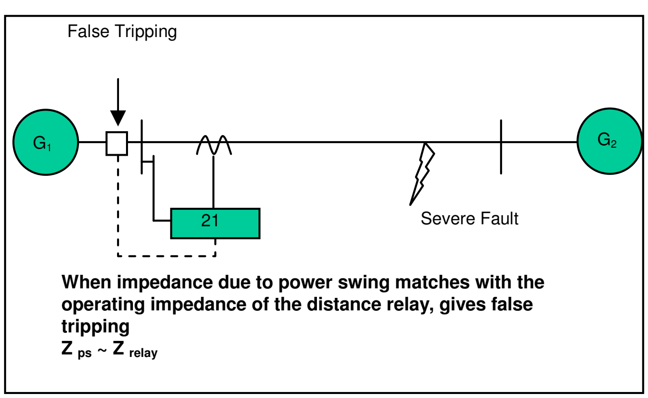

Figure 3. Wrong operation of distance relay due to Power Swing

Distance or other relays should not trip during such as stable or unstable power swings, and allow the power system to return to a stable operating condition. Distance relay elements prone to operate during stable or transient power swings should be temporarily inhibited from operating to prevent system separation from occurring at random or in other than pre-selected locations. A Power Swing Block (PSB) function is available in modern relays to prevent unwanted distance relay element operation during power swings. The main purpose of the PSB function is to differentiate between faults and power swings and block distance or other relay elements from operating during a power swing. However, faults that occur during a power swing must be detected and cleared with a high degree of selectivity and dependability. Severe system disturbances could cause large separation of the rotor angles between groups of generators and eventual loss of synchronism between groups of generators or between neighboring utility systems. When two areas of a power system, or two interconnected systems, lose synchronism, the areas must be separated from each other quickly and automatically to avoid equipment damage and power blackouts. Ideally, the systems should be separated in predetermined locations to maintain a load-generation balance in each of the separated areas. System separation may not always achieve the desired load-generation balance. In cases where the separated area load is in excess of local generation, some form of load shedding is necessary to avoid a complete blackout of the area. Uncontrolled tripping of circuit breakers during an Out-of- Step (OOS) condition could cause equipment damage, pose a safety concern for utility personnel, and further contribute to cascading outages and the shutdown of larger areas of the power system.

Therefore, controlled tripping of certain power system elements is necessary to prevent equipment damage and widespread power outages and to minimize the effects of the disturbance. The Out-of-Step Trip (OST) function accomplishes this separation. The main purpose of the OST function is to differentiate stable from unstable power swings and initiate system area separation at the predetermined network locations and at the appropriate source-voltage phase-angle difference between systems, in order to maintain power system stability and service continuity.

II. FUNDAMENTAL POWER-SWING DETECTION PROBLEM

Power swings can cause the load impedance which under steady state conditions, whereas within the relay's operating characteristic, to induce unwanted relay operations at different network locations. These undesirable measurements may aggravate the power-system disturbance and cause major power outages, or even power blackout. Particularly, distance relays should not trip unexpectedly during dynamic system conditions such as stable or unstable power swings, and allow the power system to return to a stable operating condition.

Thereby, a Power Swing Block (PSB) function is adopted in modern relays to prevent unwanted distance relay element operation during power swing [1]. The main purpose of the PSB function is to differentiate between power faults and power swings, and block distance or other relay elements from operations during a power swing.

It should be prudent to master the impacts to power system brought by power swing, especially for Out-of-Step (OOS) phenomena, which is same as an unstable power swing [4]. Uncontrolled tripping of circuit breakers during an OOS condition could cause equipment damage, pose a safety concern for operating personnel, and further contribute to cascading outage and shutdown of larger areas of the power system. So, the main purpose of the Out-of-Step Trip (OST) function should be taken into account to accomplish differentiation stable from unstable power swings, and separation to system areas at the predetermined network locations and at the appropriate source-voltage phase-angle difference between systems, in order to maintain power system stability and service continuity.

III. POWER SWING DETECTION METHODS

For power swing detection methods, this section covers traditional methods for PSB and OST based on the rate of change of impedance and advanced methods used in microprocessor-based relays.

A. Traditional

Traditionally, according to detecting the difference in the rate of change of the positive-sequence impedance vector, we can distinguish a power swing or an OOS condition. This detection method is based on the fact that it takes a certain time for the rotor angle to advance because of system inertias. Namely, the rate of change of the impedance phasor is slow during power swings, while situation is exactly converse during a system fault with very fast changing of the impedance rate [1].

Practical implementation of measuring the rate of change of the impedance is normally performed through the use of two impedance measurement elements together with a timing device. If the measured impedance stays between the settings of the two impedance measurement elements for a predetermined time, the relay declares a power swing condition and issues a blocking signal to block the distance relay element operation. After a predetermined time the relay will trip if the power swing element is not reset. A timer is started when the apparent impedance enters the outer characteristic, see Fig. 3.

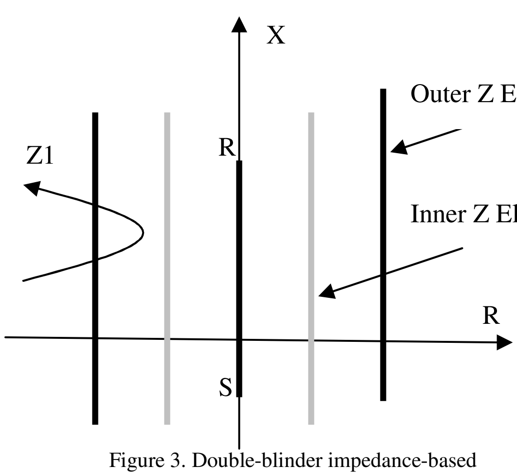

Figure 3. Double-blinder impedance-based Power Swing detection characteristic

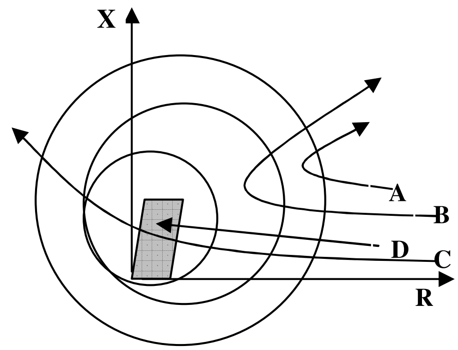

Figure 4. "Mho" type Out-of-Step detector

If the apparent impedance remains between the inner and outer characteristics for the setting time delay, the PSB element operates and selected distance element zones are blocked from operation for a period of time.

An out-of-step tripping scheme may use the same measuring element or a different set of measuring elements. The general operation is similar to PSB except the expected behavior is that the apparent impedance passes through both the inner and outer characteristic (see Fig. 4).

Where:

Shadow area: Fault zone

A: Z moves into OOS zone and leaves slowly

B: Z moves into OOS & Trip zones and leaves slowly

C: Z moves slowly across = network becomes asynchronous

D: Fault = Z moves rapidly into Trip zone

When the criteria for power swing detection are not met and when out-of-step tripping is selected, all zones of the relay are blocked temporarily, in order to prevent premature tripping [4]. When impedance vector "Z" leaves the power swing area, the vector is checked by its "R" component. If the component still has the same sign as at the point of entry, the power swing is in the process of stabilizing. Otherwise, the vector has passed through the Mho characteristic (trace "C" in Fig. 4) indicating loss of synchronism.

B. Advanced

The advent of digital technology has given relay design engineers the ability to develop and realize new methods for detecting power swings. Reference [1] [3] outline numerous new techniques, which do not require user-entered settings and greatly simplify the application of power swing detection and protection.

Some of these new methods determine a power swing condition based on a continuous impedance calculation. For example, an impedance calculation is performed for each 5ms step, and compared with the previous 5ms' result. Thus two continuous deviations can be predicted as traveling impedance because of power swing.

Others estimate the Electrical System Center, i.e. Voltage Zero, which is the point or points in the system where the voltage becomes zero during an unstable power swing, and determine if there is a power swing with detecting Voltage Zero's rate of change.

In addition, Synchrophasor-based Out-of-Step Relaying measurement has also been proposed as a way to detect and take action for power swings. Many utilities are currently evaluating the use and application of synchronized phasor measurement systems. As this technology develops, new and innovative methods of power swing detection are sure to be developed.

IV. SETTING THE POWER SWING BLOCKING SCHEME

Setting a power swing element is typically accomplished by extensive and time-consuming stability studies. Although using the stability study to set the power swing element is the best method, power swing elements can also be set by using known system conditions and making certain assumptions about the performance of the power system. However, these methods work well for PSB schemes but do not work well for Out-of-Step tripping.

Comparatively, using an impedance-based setting method performs well for most applications [1], particularly those where there are not significant changes in the source and transfer impedance.

Once the equivalent impedances are calculated, another piece of information is required, the power swing slip rate, which is equivalent to the rate at which the system is oscillating or the rate of change of impedance as viewed from the relay location.

Reference [1] [3] outline a few steps for setting the PSB blinder schemes shown in Fig. 3.

1. Set the outer characteristic impedance blinders inside the maximum possible load with some safety margin.

2. Set the inner impedance blinders outside the most over-reaching protection zone that is to be blocked when a swing condition occurs.

3. Based on the outer and inner blinders set previously, the predetermined PSB timer value, T1, can be calculated from the equation (3), while the maximum slip frequency, Fslip, is also assumed between 4 to 7 Hz.

$$T1 = \frac{(Ang1R - Ang2R) * Fnom(Hz)}{360 * Fslip(Hz)}(cycle) \qquad (3)$$

From Fig. 5, we know it is difficult to obtain the proper source impedances in a complex power system, which are necessary to establish the blinder and PSB timer settings.

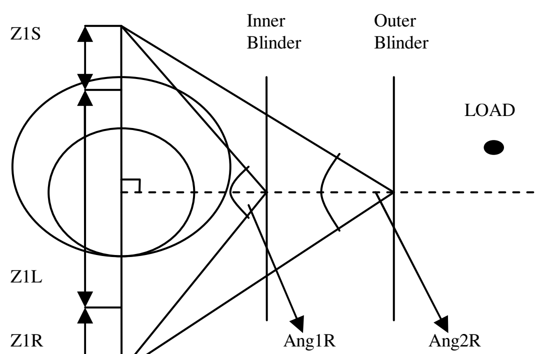

Figure 5. Equivalent two-source machine angles during OOS

where:

$Z1S$: the local source impedance

$Z1L$: the line impedance

$Z1R$: the remote source impedance

$Ang2R$ and $Ang1R$: machine angles at the outer and inner blinder reaches, respectively

Normally, very detailed system stability studies are necessary to consider all contingency conditions to construct equivalent source impedance for conventional PSB function.

Besides, a modern relaying system with "load encroachment" capabilities should be required, because the load region will be close to the distance element that needs to be blocked when suffering a long line with heavy loads [1].

V. CONCLUSIONS

Power swing is a variation in three-phrase power flow which occurs when the generator angles are advancing or retarding relative to each other in response to changes in load magnitudes and direction, line switching, loss of generation, faults, and other system disturbance.

In real applications, PSB elements may be set using an impedance-based method requiring development of system equivalents. Power swing tripping must be set using data obtained from extensive stability studies. It is difficult to calculate all of the varying system conditions, create boundary equivalents, and then determine the best place to apply the scheme and separate the system.

Besides, it is not recommended to apply PSB for unstable power swings without some form of OST being applied at some scheduled location.

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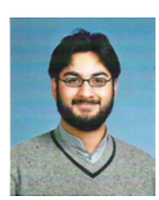

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Poznań

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BTU Cottbus

Abstract: **This Paper contains information about the historical development and the sights of Poznań.**

I. INTRODUCTION

Poznań is the 5th largest city in Poland. It is also one of the oldest cities in Poland, which makes it to an important historical center. Today the city is a vital center for industry, trade and education.

Fig. 1 shows that Poznań is located in west-central Poland and is situated by the river Warta. The city has a population of well over 600 000 people, whereby the most of them belong to the roman-catholic religion [1].

Figure 1: Location of Poznań

II. HISTORY

Poznań lies in the Region in which the polish state was founded. It has witnessed a number of significant historical occurrences. Through the ages Poznań has overcome some magnificent forces and has an essential effect on Poland's present status.

The history of Poznań starts with a stronghold, which was built on an island in the forks of the rivers Warta and Cybrina, the Ostrów Tumski. This happened in the 8th – 9th century [2]. After that a number of Polish dukes settled in Poznań. In 968 the first cathedral and the first bishoprics were founded. At the beginning of the 12th century Poznań became the capital of Greater Poland. During the next time Poznań developed very quickly and was surrounded by trade-and-craft settlements. Based on the Teutonic Law a settlement was formed on the present of Old Market Square. Thomas of Guben was the first mayor of the local government. In the following years he brought many German settlers to the city. During the unification of Poland in the 13th century, Poznań became the main political, cultural, academic and economic center. In 1519 the first Academy in Poznań was founded. It is still named after Lubrański. The "Golden Age" of Poznań has been in the 16th century, because the population grew up to 20 000. So it became to one of the biggest cities in Poland. Because of the Swedish Invasion in 1655 the development fulfilled a sudden regression. After 1780 the economic boom started again and several waves of settlers brought new cultural elements to the city.

In 1793 with the second division of Poland Poznań fell to the Kingdom of Prussia and was made the capital of the province of South Prussia. During the Nepoleonic Wars in 1806 the city was liberated and until 1815 it was the capital of the Poznań department.

According to the Vienna peace congress Poznań again fell to Prussia and was made the capital of the Grand Duchy of Poznań. In 1848 the duchy was renamed the Province of Posen. Then in 1871, it became part of the German Empire. The reason was the unification of Germany by the Prussian king. At that time the population of Poznań was half Polish and half German. In 1848 the proportion of Germans came up to the peak of 60 %. During that time Poznan became a town inside a polygonal fortress.

After World War I the Versailles peace treaty stated that most of Posen province assigned to Poland. German inhabitants had the options to stay or leave. The proportions of Germans decreased to 10 %.

With the beginning of World War II Poznań was annexed by Germany and reorganized. The German army started immediately the "re-germanisation of Poznan", which also meant that many polish and Jewish people were murdered or left Poznań as slave workers. After World War II 55% of the city and 90% of old town was destroyed.

Between 1945 and 1948 Poznań went through the era of enthusiasm for peace and freedom. The city was rebuilt from ruins and characterized by relative political freedom. After 1947 Poland was put under strict control of communist party and the Sovietisation of the state and economy.

In 1957 Poznań was excluded and organized as a separate administrative unit. In 1975 it became the capital of the Poznań voivodship as a result of a local government act, and in 1999 it started to administrate the Greater Poland Voivodship.

Currently Poznan is one of the major centers of trade with Germany. Many other western European companies started their Polish branches in Poznań. [2]

III. Sights Of Poznań

Poznan has several significant places of interests. Lots of them have historical background. Poznan is also a city with a considerable number of old churches. The Archchathedral Basilica of St. Peter and St. Paul is one of the oldest churches in Poland and the oldest Polish cathedral. It is also Poznań's oldest historical monument.

A. Cathedral of St. Peter and St. Paul

Figure 2: The cathedral

The cathedral, that is shown in Figure 2, was built in 968 by Prince Mieszko I, when the first missionary, Bishop Jordan, came to Poland. Many times it was destroyed and restored in several architecture styles. Today the cathedral is a three-nave basilica, with an ambulatory around the chancel. It has 2 sacristies adjacent to the side naves and the ambulatory and 12 chapels. When the church was constructed first it was 48 meters in length and a pre-Romanesque style. In the basements of today's basilica parts of this building are still visible. The facade has a pointed offset portal made out of glazed, profiled bricks. The bronze door shows scenes of the lives of St. Peter and St. Paul. These pictures were made in 1979 and were designed by K. Bieńkowski. The cathedral has also a significant high Gothic window with a rosette over the portal. Many precious works of art can be found in the cathedral. The high altar from 1512 is build in late Gothic style and comes from Góra in Lower Silesia. Above the altar there is a late Baroque crucifix and a Baroque Statues of Mother of God and St. John. The chapels are also home of many valuable works of art. Between 1835 – 41 Franciszek Maria Lanci designed a Golden Chapel as a mausoleum of Mieszko I and Boleslaw the Mighty, who were the first rulers of the Polish State. The cathedral was the stage for many historical events, including the funerals of medival kings and princes. [2],[3]

B. Town Hall and the Marketplace

The marketplace, established in 1253, is situated on the left bank of the Warta River. The square is the third biggest in Poland, loosing only compared to the squares in Wrocław and Krakow. Three streets are running out of the place on each side of the square. They divide the marketplace into two sections.

During the liberation of Poznań in 1945, 60 % of all the buildings were destroyed, a lot of them by fire. Straight after the destruction the rebuilding started in the very same year. After the reconstruction the marketplace lost its commercial character, becoming instead a residential area with many cultural institutions. Some years later many fashionable cafes, restaurants and shops that sell souvenirs were opened.[2], [4]

Figure 3: Town Hall

Originally the marketplace was built up with administrative and commercial buildings. One of them is the old Town Hall, which is shown in Figure 3. In the 13th century the Gothic Town Hall was at first an unimposing two-storey building. Then in the early 16th century the tall towers were built. Shortly after that Giovanni Batista Quadro of Lugano reconstructed the Town Hall in the Renaissance style. Previously the Town Hall was the seat of the city council and was seen as one of the most valuable Renaissance architecture monuments in central Europe. The building's most impressive feature is its front elevation with its colonnaded three-storey loggia and turrets above it. Between the first and the second floor medallions are situated which show portray heads of wise men and heroes of the antiquity. Heads of the Polish kings from the Jagiellonia dynasty are featured in the attic storey. Under the clock in the central turret there is a cartouche with the initials of King Stanislaus Augustus. And above the clock there is a small ledge where a pair of billy goats appears every day at noon. The oldest part of the building is the Gothic cellar with their groined-rib vaulting. On the first floor there are the most interesting rooms. The Renaissance Room, also known as the Great Hall, boasts one of the most beautiful Renaissance interiors in Poland, which has to be seen.[2]

Acknowledgment

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Impact of Secondary Burden and X/R Ratio on CT Saturation

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***Abstract* – Proper selection of a CT (Current Transducer) is required for a good protection scheme operation. Among many other factors which can affect the current measurements accuracy this paper only investigates two of them i.e.: X/R ratio of the primary fault path and secondary burden of a CT. The importance of taking this two parameters under consideration is shown.**

I. INTRODUCTION

Current measurements are most often conducted with the use of iron-core CTs which are relatively cheap and reliable devices. Their major disadvantage is that ferromagnetic core saturates and this affects the secondary current of a CT. The CT saturation occurs when the magnetic flux exceeds the linear region on the CT magnetizing characteristic. This effect strongly depends on a fault current and the CT secondary burden. The bigger the difference between the primary and secondary current the less information is given to a protective relay and this can lead to a relay malfunction.

One possible solution of this problem is increasing the core size which would allow measurements of a higher current. This is yet unacceptable from an economical point of view. That is why it is desired to choose a CT suitable for specified conditions such as X/R ratio and CT secondary burden. The first can be estimated since the parameters of a power line are known. The latter is the impedance not only of a relay itself but also CT wire impedance and wire connecting relay with a CT (pilots) [1].

Simulations were conducted with use of electro-magnetic transient program (EMTP). Fig. 1 presents test circuit used for simulations. The primary impedance of the CT was neglected as also was the resistance in the magnetizing branch. Nonlinearity of the core was simulated using nonlinear inductor (Type 98) and Fig. 2 shows its excitation curve. CT ratio is 1000:5.

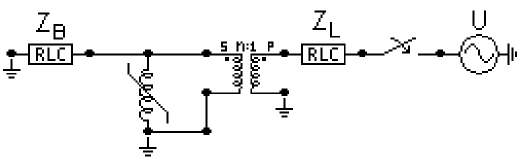

Fig. 1. Simulation model [2].

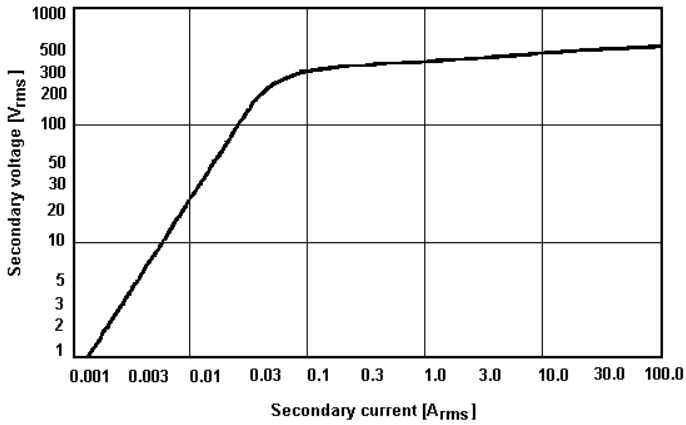

Fig. 2. Excitation curve of the inductor used in simulation.

For the sake of simplicity residual magnetization was neglected in the simulation.

II. SIMULATIONS

A. Impact of secondary burden

Relay impedance (especially if it is a modern one) is relatively small. The most important part of the burden of a relay is the impedance of pilots and it is almost only resistance. Table 1 shows values used for this simulation.

TABLE 1
VALUES OF PARAMETERS USED IN THE SIMULATION

R_B	0.3 ; 3.0 ; 5.0; 10 Ω
X_B	0.01 Ω
X_L/R_L	8
U	110 kV_{RMS}
I_f	Approx. 13.6 kA
f	60 Hz

Fig. 3 presents the secondary current versus time and in this case no saturation can be observed. As the burden was increased the waveform distortions were more visible (Fig. 4). This proves that even relative small burden can influence CT accuracy if the fault current is not correctly anticipated.

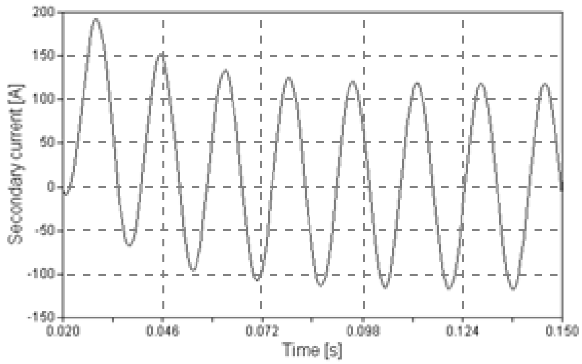

Fig. 3. Undistorted secondary current (R_B = 0.3 Ω).

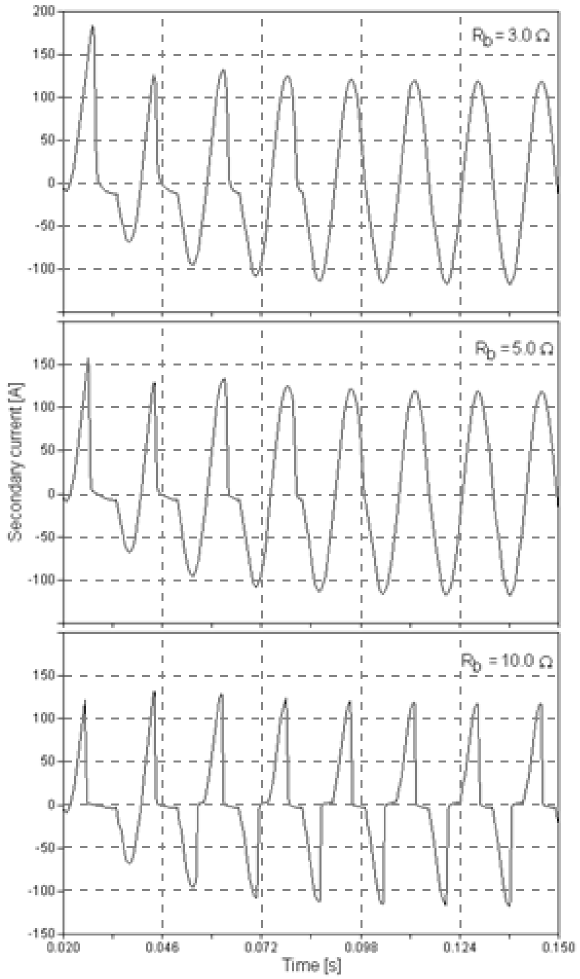

Fig. 4. Distortions in secondary current dependent on the CT burden.

B. Impact of X/R ratio

X/R ratio is an important parameter when considering CT saturation because it is responsible for the decaying DC component in fault current. Since this DC component produces an almost constant magnetic flux (in comparison with magnetic flux produced by a 50 Hz sine wave) it significantly contributes to CT saturation [4].

Table 2 shows values used for this simulation. Since it was desired to show only the influence of the X/R ratio the steady-state fault current value had to be the same for every simulation. This can be achieved only when both (1) and (2) are satisfied at the same time. Table 2 shows values obtained after solving this set of equations.

$$|Z_L| = \sqrt{R_L^2 + X_L^2} = const \qquad (1)$$

$$\frac{X_L}{R_L} = 8\,;10\,;15\,;20 \qquad (2)$$

TABLE 2
VALUES OF R AND X FOR DIFFERENT X/R RATIOS

X_L/R_L	R_L [Ω]	X_L [Ω]
8	1.000	8.000
10	0.802	8.022
15	0.536	8.044
20	0.403	8.052

In the following simulations burden was held constant at Z_B = 3+j0.1 Ω. Fig. 5 presents secondary current waveform for X/R=8 which is only slightly distorted. As the reactive part of the fault path impedance increased distortions were more visible (Fig. 6). In opposition to distortions caused by the CT burden, in this case not only the shape of the waveform was distorted but also was the amplitude of the fault current. When simulating X/R = 20 approximately 20 ms after the fault amplitude of the current was 90 A, where the amplitude of the steady-state fault current was 120 A. This difference increases with the increase of X/R ratio as also does the time required for the fault current to reach its steady-state value. Two types of distortions: in shape and in amplitude can make the current measured in the first few cycles to be extremely inaccurate.

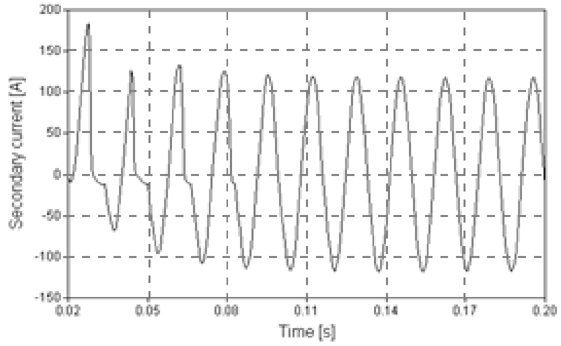

Fig.5. Secondary current for X/R = 8.

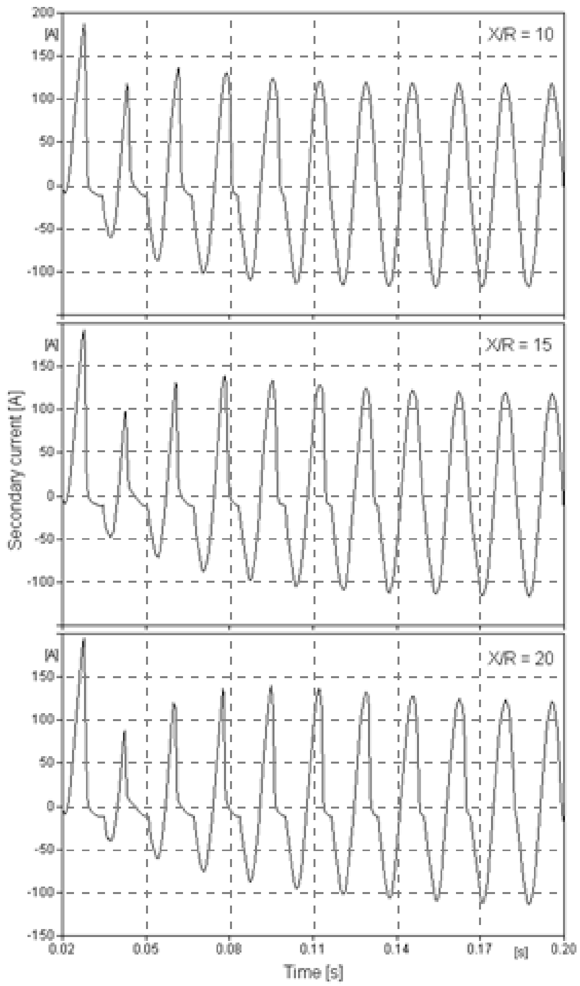

Fig. 6. Distortions in secondary current dependent on the X/R ratio.

III. Conclusions

Conducted simulations show the importance of a proper choice of a CT. Influence of both secondary burden and X/R ratio was investigated and it proved that not taking even one of those factors into account can cause a CT to produce a highly distorted secondary current.

After changing the burden from 0.3 Ω to 3.0 Ω a small indication of core saturation was observed for at least 4 cycles after the fault. After setting burden to 10.0 Ω distortions were present during the whole simulation and they caused RMS current to be smaller than in fact it was. This is extremely important since one of the fundamental protection criteria is based on that value. Since it is often the case that the connecting wire resistance plays the most important part in CT burden it is required to place relays as close to a CT as it is possible. If from some reasons this is difficult to achieve a different CT should be chosen. In case of replacing a relay with a new one it is also advisable to investigate the influence of this change on the CT burden.

In the simulation X/R ratio had a smaller impact on secondary current distortion nevertheless this influence cannot be underestimated. For example when X/R ratio was set to 20 first few cycles were significantly distorted. With further increase of X/R this impact is even more severe. It was also observed that with the increase of X/R ratio the difference between the minimum fault current and the steady-state fault current increases. This means that for a highly reactive fault path the current measured by a CT in the first few cycles is significantly smaller than the actual fault current. This can cause the relay to trip after a longer period of time than it was originally anticipated. Since X/R ratio cannot be altered for the power protection purpose it can only be suggested that the described phenomenon should be carefully taken under consideration when choosing a CT.

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Guenter Grass
His life and his relationship to Poland

Christian Knerndel
Marcus Dintinger

I. Biography

Guenter Grass was born on the 16th October, 1927 in Gdansk Langfuhr. His father was a Protestant and grocer, the mother was a Catholic. Besides he had a sister called Waltraut. Guenter Grass grew up in easy relations and by the influence of his Catholic mother; he already worked in his youth as a measuring servant. From 1933 to 1944 he visited the elementary school and the high school in Gdansk. At the age of 15 years he announced himself voluntarily to the military service. Reason for this was according to his statement to escape from the informal narrowness (i.e. a 2 room flat without bath for 4 persons). In 1944 he was called up as an air force assistant and in the same year still for the 10-th SS-armoured division. In 1946 he got in American captivity. After his release in 1946 he wanted to finish the school-leaving exam in Göttingen, then, he considered differently and worked possibly during 1 year as a belt boy and in a potash mine. In 1947/48 he finished an education stonecutter. Afterwards he studied till 1952 graphic arts and sculpture at the academy of arts in Duesseldorf. In parallel addition he started to write. In 1956/57 he had the first exhibits of his works and joined to the "group 47". This was an alliance of authors who have done the clarification and education the democracy in Germany to the purpose to themselves. In 1960 Grass resettled to Berlin where he lived with bigger interruptions – for example Wewelsfleth (in 1972-1987). Today he lives in Behlendorf near Mölln (Schleswig - Holstein).

II.1. Works

Guenter Grass is a very chameleonic artist, after his study for sculpture and graphic arts he engaged in many sectors of the art. Grass began his literary career as a lyricist, but his first poem-books were, like his first stage plays rather from moderate success. His first novel "Die Blechtrommel" (1959) founded his worldwide fame and brought him the Nobel-Prize for literature in 1999. Together with the novel "Katz und Maus" (1961) and novel "Hundejahre" (1963), "Die Blechtrommel" formed the Gdansk trilogy and they described destinies of figures and events in Gdansk in the time of the Second World War. Guenter Grass is known as a politically engaged author and always dealt with political, cultural and social circumstances, as for example in the novel "Ein weites Feld" (1995) with the German reunion.
His last work "Beim Häuten einer Zwiebel" was released in the year 2006 and has an autobiographic character, it begins with the excavation of the Second World War in Gdansk and there he reveals that he was a member of the SS what was treated very controversially. Nevertheless, Grass was not only famous for his literary works, he also sketched numerous sculptures and graphics and more over his novels also were frequently a basic for film adaptation and theatre plays.

II.2. Die Blechtrommel

"Die Blechtrommel" appeared in 1959 as the first part of the Gdansk trilogy and belongs to the most important novels of the German post-war literature. The cinematic adaptation in 1979 made by Volker Schlöndorff was assigned with an Oscar for the best not English-speaking movie. At the beginning of the eighties "Die Blechtrommel" appeared in Polish, he was cheered by the Polish people on grounds of the overriding quality of the novel, on the other hand the critics mocked the novel as historic incorrect and complained about, that according to that some polish mind's are blessed.

The novel is about the person Oskar Matzerath who comes into the world in 1924 in Gdansk. At that time his mind is already developed completely, one says in the book that his "spiritual development is already concluded in the birth and only must be confirmed from now on".
Because he does not grow since his third birthday any more, he can report therefore as a child from the perspective from below about the world of the adults. In his third birthday he gets as a gift of his mother a metal drum which becomes his constant companion.
The novel is divided in episodes which describe the life of Polish and German lower middle-class families in Gdansk. He mentioned the living conditions which obtained in the time of the Second World War and the circumstances linked with it of the everyday life. Oskar tries to understand the insanity and confusion of the war with his stories and sees everything from his own view.

II.3. Role of Gdansk in the novel

The city of Gdansk plays an important role in the novel with her partly Polish, partly German inhabitants. Oskar comes on the mother's side from a kaschubic family by which is said, that it is not Polish enough for the Poles and not is German enough for the Germans. Indeed Oskar confesses over and over again to his Polish roots, because his drum is not accidental "red-white patterned". Over and over again Grass comes up to the history of the city of Gdansk and her varying governments.

III. Grass' relationship to Poland

III.1. Engagement

Guenter Grass has exerted himself in the sixties for the recognition of the Oder-Neisse border. At that time he supported Willi Brandt with his election campaign, while he used his popularity and held for the purposes of the SPD election speeches. Later Willi Brandt signed the contract for the recognition of the in German Polish border. In his works he convicted and processed scare of the National Socialism. For example in „Katz und Maus" he demonstrated the knight's cross as ridiculous there, while he produced it as a life purpose for pubescent outsiders and mentioned it only thing, article or similarly. His book „Unkenrufe" is about the expulsion, reconciliation and the relation of polish people and Germans. Besides he expressed critically on the planned "centre against expulsion". Behind the background of the late admission to his membership at the SS, the polish people handled him with forbearance. Anyhow a 3-day city party was organised, for him, to his eightieth birthday in Gdansk and the climax was a discussion with Grass and the former presidents of Germany and Poland, Richard von Weizsäcker and Lech Walesa about the German – Polish relationship. In 2001 author and Nobel Prize Laureate for Literature Guenter Grass became the Viadrina price from European university of Frankfurt/Oder. This price will award to prominent personalities for special salaries around the German Polish notification. Guenter Grass was the third prize-winner beside Karl Dedecius and Adam Michnik. The Prize founder Claus Detjen payed tribute to Grass for his engagement in Germany-Poland relationship, and concluded that without help of Guenter Grass, it would not have been possible for opening of the border for the extension of the European Union, if Guenter Grass had not moved heads in Poland and had opened senses. Grass stressed in his acknowledgement, that good-neighbour relations can be sworn not only by well-meaning speeches, but also the actions must follow. An example for this is to debilitate the word 'Beutekunst', while both nations must stop the possession claims and build together a museum in which the controversial pictures and sculptures find her remaining place.

III.2 Public opinions

Referring to his past and the late confession linked with that he was a member of the SS, the opinions about Guenter Grass are divided. He is mocked by a part of the polish people and honoured from others, reported the internet-newspaper „new press". After he has confessed to the weapon SS, he should be neither for polish people nor for Germans an authority's person, the polish Catholic party „Right and Justice" rushed. The best known member of this party is Jarosław Kaczyński.

Besides they also demanded the denial of the Nobel Prize for Literature and his Gdansk honorary citizen. However, ¾ of the Gdansk people thinks, that it is not right to deprive him his honorary citizen. Grass thanked the polish people for that with the statement " The tolerance of Gdansk people helped me during difficult days very much. The Zurich "day indicator" called Guenter Grass a "false moralist with lack of humility: " Another opinion has the philosopher Ruediger Safranski. He gave respect to Grass that it is a good method "To do a conscience to other to finish around with own pangs of conscience ". Some persons held it even for a marketing calculation, because the confession came shortly before the appearance of his book "Beim Häuten der Zwiebel". But it is a moot point, if this is helpful marketing for selling books with this statement.

IV. The Guenter Grass Beneficence

On the 20th October, 2000 the Guenter Grass Beneficence Bremen was founded to collect the "audio-visual work of Guenter Grass, to document it and to give access to the interested general publicity". The endowment was founded by the hanseatic town Bremen and Bremen enterprises, the research and documentation place is in the Jacobs University Bremen.

It is an aim of the beneficence to publish more about the creative power of the author. The literary and picture-artistic works, as well as the numerous picture admissions and sound-recordings of the Nobel Prize Laureate should be summarised into an archive. The beneficence awards in the distance of two years the so-called albatross price which is endowed with 40,000 € for the author. The price goes to international authors for "contemporary narrative prose, lyric or essayistic".

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Stadt Breslau/Wrocław

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IEEE Conference
Brandenburgische Technische Universität Cottbus
Fakultät 3

Im folgenden Artikel wird über die Stadt Breslau berichtet und ihre deutsche und polnische Geschichte und Kultur informiert.

I. Übersicht und Geographie

Die Stadt Breslau (pol. Wrocław) ist mit über 635.200 Einwohnern die viertgrößte Stadt Polens. Sie ist die Hauptstadt von Niederschlesien und deren Verwaltungssitz. Breslau hat eine Fläche von 293 km² und liegt an der Einmündung der Ohle in die Oder, und wurde zwischen zahlreichen Nebenflüssen und Kanälen gebaut. Sie steht auf 12 Inseln und hat insgesamt 112 Brücken. Aufgrund der zahlreichen Brücken und Stege wird die Stadt auch als Venedig Polens bezeichnet.

Bild 1. Das Breslauer Stadtwappen
verwendet 1530 bis 1938, 1945 bis 1948 und wieder seit 1990

II. Wirtschaft

Die Stadt ist Inovationszentrum von Polen und etabliert sich zunehmend als überregionales Wirtschaftszentrum im Dreiländereck Polen, Deutschland und Tschechien. In den letzten Jahren haben sich zahlreiche ausländische Investoren in dem von der Stadt errichteten Technologiepark angesiedelt. Unter anderem sind Firmen wie Cadbury, IKEA, Auchan, Carrefour, Tesco, Makro Cash & Carry, Castorama und Cargill in Breslau ansässig. Außerdem befinden sich im äußeren Umfeld von Breslau Firmen wie Bosch, Toyota, Siemens, SAP und LG Electronics, welche 2007 mit einer neuen Fabrik etwa 12.500 Arbeitsplätze geschaffen haben. Die vielen ausländischen Investoren haben zu einer für Polen relativ geringen Arbeitslosenrate von 8,1% im 4. Quartal 2006 beigetragen.

III. Kultur

Breslau hat 9 Museum, 10 Theater, eine Oper, eine Operette sowie eine Philharmonie und ein Puppentheater. Jedes Jahr finden in der Stadt eine Reihe von Festivals statt, unter anderem Filmfestival, Literaturfestival und viele Musikfestivals, welche sich über alle möglichen Richtungen erstrecken, wie zum Beispiel Jazz, Techno oder Orgelmusik. Da Breslau eine Stadt mit sehr vielen Studenten ist, ist vor allem das Nachtleben sehr belebt, um den Marktplatz befinden sich zahlreiche Clubs und Bars, wo häufig Veranstaltungen mit bekannten Künstlern stattfinden.

IV. Bildung

In Breslau befinden sich zehn Hochschulen. Eine davon ist die Universität Breslau, sie ist mit 43.000 Studenten die größte Universität der Stadt, sie wurde bereits 1702 von Jesuiten gegründet und 1811 unter der Regierung von Friedrich Wilhelm III von Preußen erneuert. Er versetzte die Universitas Viadrina von Frankfurt (Oder) nach Breslau. Die Universität steht an der Stelle der alten Königlichen Burg von Breslau und ist heute eines der schönsten Baudenkmäler des österreichischen Barock. Sie fasst 10 Fakultäten. Ein berühmter Dozent war Gustav Robert Kirchhoff, Professor der Physik. Außerdem gibt es noch die Technische Hochschule Breslau mit 35.000 Studenten, die Wirtschaftshochschule Oskar Lange mit 18.000 Studenten und viele weitere Hochschulen, wie die Offizierhochschule des Heeres, die Naturwissenschaftliche Universität mit13.000 Studenten, die Medizinische Hochschule, eine Musikhochschule, eine Kunsthochschule, eine Sporthochschule, sowie eine Päpstliche Theologische Fakultät, außerdem noch etwa 15 andere weiterführende Schulen und Sprachschulen. Mit 141.388 eingeschriebenen Studenten am Ende des Jahres 2006 ist Breslau das Hochschulzentrum Polens.

V. Deutsch – Polnische Geschichte

Die Stadt Breslau hat eine gemeinsame deutsch- polnische Geschichte, so gehört Breslau bereits 990 zum polnischen Staat. Allerdings verzichtet der polnische König 1348 auf Schlesien und somit auch auf Breslau und die Stadt geht an Böhmen und später an Habsburg. Nach der Rückkehr von Martin Opitz, dem Begründer der Schlesischen Dichterschule, von seinen Reisen 1630 wird Breslau die Hauptstadt der Deutschen Literatur und bleibt es bis 1670. Nach einer Kapitulation vor Friedrich dem Großen 1742 übergibt Österreich Breslau an Preußen. Im 19. Jahrhundert wächst Breslau bis zu einer Einwohnerzahl von knapp 500.000 und ist zeitweise neben Leipzig die fünftgrößte Stadt Deutschlands. Jedoch sprechen 1910 nur 95,7% der Bevölkerung deutsch, der Rest spricht Polnisch und Tschechisch. Uns so wird gleich nach der Wahl 1933 in Breslau- Dürrgoy ein Lager für männliche politische Gefangene errichtet, dieses wurde jedoch gleich im März des gleichen Jahres wieder geschlossen. Aber Mitte 1944 wurden abermals 2 Lager errichtet, sie dienen als Arbeitslager des KZ Groß- Rosen, diese wurden im Januar 1945 geschlossen. Am 7. Mai kapituliert die Stadt vor der roten Armee, zu der Zeit liegen 400 bekannte Baudenkmäler in Ruinen. Gleich 2 Tage später übergeben Sowjetische Militärbehörden die Verwaltung von Breslau an Polen. Allerdings befinden sich noch 300.000 Deutsche in der Stadt, die nach und nach ausgesiedelt werden. Besiedelt wird die Stadt von Neu- Breslauern aus Zentralpolen. Mit dem Potsdamer Abkommen vom 2. 8. 1945 erhält Polen endgültig die Verwaltungshoheit in Schlesien und wird von der Sowjetunion aufgefordert die Zwangsaussiedlung der deutschen Bevölkerung in humaner Weise durchzuführen. So wurden am. März alle deutschen Bewohner ihres Hab und Gut enteignet und so im Sommer 1946 liegt die Zahl der polnischen Bevölkerung in Breslau bereits bei 30.000. Bereits 1948 hat die Stadt schon 300.000 polnische und 7.000 deutsche Einwohner. Seid 1990 nimmt der Wiederaufbau Breslaus sich auch deutschen Kulturerbes an und integriert dieses in die polnische Breslauer Lokalidentität.

VI. Sehenswürdigkeiten

Breslau bietet eine große Vielfalt an Sehenswürdigkeiten. In der Stadt- und Dominsel stehen zahlreiche Kirchen, fast alle in unterschiedlichen Stilen gebaut, zum Beispiel die St. Annakirche aus dem Barock, oder die frühgotische St. Martinkirche, sowie sehr viele weitere Kirchen. Auch auf der Dominsel ist der Breslauer Dom zu finden, er gehört mit seinen zwei 98m hohen Kirchtürmen zum Größten der Stadt. Der Dom gehört zu den bedeutendsten Sehenswürdigkeiten Breslaus und ist eines seiner Wahrzeichen. Ein anderes Wahrzeichen ist Breslaus Rathaus, welches sich in der Altstadt am dem Ring befindet, es wurde bereits im 13 Jahrhundert gebaut und dessen Türme sind ungefähr 66m hoch. Im 13 Jahrhundert entstand auch der Ring, das ist ein Mittelalterlicher Marktplatz und er bildet heutzutage den Kern der Fußgängerzone. An ihm stehen zahlreiche Mittelalterliche Bürgerhäuser, das Rathaus, sowie das neue Rathaus. Ebenso sind in der Altstadt viele Kirchen zu finden und die Universität Breslau steht auch hier, wie auch Das Nationalmuseum, welches im ehemaligen „alten Regierungsgebäude“ zu finden ist. Eine weitere wichtige Sehenswürdigkeit ist das Panorama Raclawicka, das ist ein gigantisches Rundgemälde mit 120 Metern Länge und einer Höhe von 15 Meter. Es stellt die schlacht bei Raclawice am 4. April 1794 dar. Im südlichen Außenviertel ist der Wasserturm Breslau zu finden, das ist ein ehemaliger Wasser- und Aussichtsturm im Stadtteil Borek. Er ist 63 Meter hoch und auf einer Höhe von 42 Metern befindet sich eine Aussichtsgallerie, von der aus man die gesamte Stadt überblicken kann. Ganz in seiner Nähe befindet sich einer von den 2 erhaltenen Jüdischen Friedhöfen Breslaus. Er bietet einen Einblick in die Geschichte der Juden in Breslau. In der östlichen Stadt Steht die Jahrhunderthalle, ein wichtiges Bauwerk für Breslau. Sie wurde 1911-1913 gebaut und für die Jahrhundertausstellung zur Erinnerung an die preußischen Befreiungskriege gegen Napoleon genutzt. Die Kuppel war mit 65 Metern Spannweite weltweit die größte dieser Art, deswegen wurde die Halle 2006 zum Weltkulturerbe erklärt. Heute wird die Halle noch für Messen, Sport- und Musikveranstaltungen genutzt.

Bild 2. Die Jahrhunderthalle heute

VII. Breslaus Persönlichkeiten

Breslau war Geburtsort zahlreicher bekannter Persönlichkeiten wie zum Beispiel Dietrich Bonhoeffer, ein deutscher evangelisch-lutherischer Theologe und Widerstandskämpfer gegen den Nationalsozialismus, Ferdinand Lassalle, ein deutscher Schriftsteller, Politiker, Staatssozialist und Arbeiterführer, Peter Lustig, ein deutscher Fernsehmoderator und Kinderbuchautor, sowie Adolph Menzel, ein Maler, Zeichner und Illustrator. Außerdem wurden zehn Nobelpreisträger in Breslau geboren, oder haben hier gewirkt, wie zum Beispiel Max Born oder Otto Stern.

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Impact of Distributed Generation on Electrical Power Network

Umar Naseem Khan

Abstract—**In today's world, the demand for the electric power is growing rapidly; to overcome this, many power generation resources are constructing in all over the globe. But the problem arises when the new generation is integrated with the power network and distribution, as the existed power network was not designed by keeping in mind the new integration of generation in the future. The objective of this paper is to discuss some of the problems associated with distribution resources on the power and network.**

Index Terms—**distributed resources, distributed generation, power system, transmission and distribution.**

I. Introduction

The power system faces many problems when distributed generation is added in the already existing system; this is because the power system is not designed with distributed generation in mind. The addition of generation could influence power quality problems, degradation in system reliability, reduction in the efficiency, over voltages and safety issues. On the other sides the power system distribution are well designed which could handle the addition of generation if there is proper grounding, transformers and protection is provided. But there are limits to the addition of distributed generations if it goes beyond its limit then it is important to modify and change the already designed distributed system equipment and protection, which could in a result facilitate the integration of new generation. This addition of the equipment could involve protection relays, switchgears, change of the voltage regulation system, revised grounding and transfer trips [1].

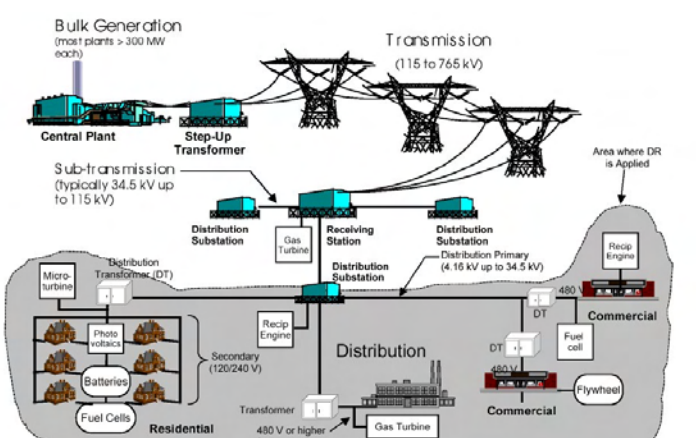

Figure 1, Distributed Resources on the Power Network

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A wide range of power generation technologies are currently in use or under development, these technologies includes: small combustion turbines and micro turbines, small steam turbines, fuel cells, small-scale hydroelectric power, photovoltaic, solar energy, wind turbines, energy storage technologies etc, as shown in Figure 1. The benefits which we can get from distributed resources (DR) in relation to Transmission and Distribution (T&D) could include reduction in T&D system losses, enhanced service reliability and quality, improved voltage regulation, relieved T&D system congestion [2].

On the other hand, interconnected DR could worsen the performance of the power system leading to negative support benefits. For example, the reliability of the power system may be degraded if the DR is not properly coordinated with the electric power system protection. The integration of DR could influence the power quality due to poor voltage regulation, voltage flickers and harmonics. These conditions can have a serious impact on the operation and integrity of the electric power system as well as cause damaging conditions to equipment.

II. The Impact of Distribution Resources on Distribution Network

Before evaluate the system impacts such as voltage regulation, faults levels, power quality, reliability, harmonics, stability and other performance characteristics one has to first collect the data that can properly describe both the DR and the utility system to which it will be connected.

Data needed to evaluate DR impacts:

- Size rating of the proposed DR
- Type of DR power converter (static or rotating machine)
- Type of DR prime energy source (such photovoltaic, wind or fuel cell
- Operating cycles
- Fault current contribution of DR
- Harmonics output content of DR
- DR power factor under various operating conditions
- Location of DR on the distribution systems
- Locations and setting of voltage regulation equipment on distribution system
- Locations and settings of equipment for over current protection on distribution system

In the following sections, some solutions are presented to overcome the issues relation to the integration of the DR [1].

III. Interconnection transformer connections

The selection of the interconnection transformer connection has a major impact on how the dispersed generator will interact with the utility system. The type of transformer employed has an impact on the grounding perceived by the utility primary system and for the generator to appear as a grounded source to the utility primary distribution systems, the transformer must be able to pass a ground path from the low voltage to the high voltage side, which is commonly called as zero-sequence path.
There is no universally accepted "best" connection. Figure 2 shows four commonly used connections. Each of these connections has advantages and disadvantages to the utility with both circuit design and protection coordination affected. Each connection should be addressed by the utility as they establish their interconnect requirements.
In Figure 2, top two arrangements shown can provide a grounding path to the primary. Furthermore, for the transformer with grounded wye, the generator neutral must be grounded to make the source appear as grounded. The top two arrangements are preferred for four-wire multi-grounded neutral systems. The bottom two arrangements shown act as grounded sources and are best used on the three-wire, ungrounded distribution systems. An important point is that a DR site can be configured to acts as a well-grounded source on the low-voltage side of the transformer, but the system may still appear to the utility primary to be ungrounded an the high side. Delta connection on the high side and grounded-wye connection on the low side can achieve this effect [1], [2].

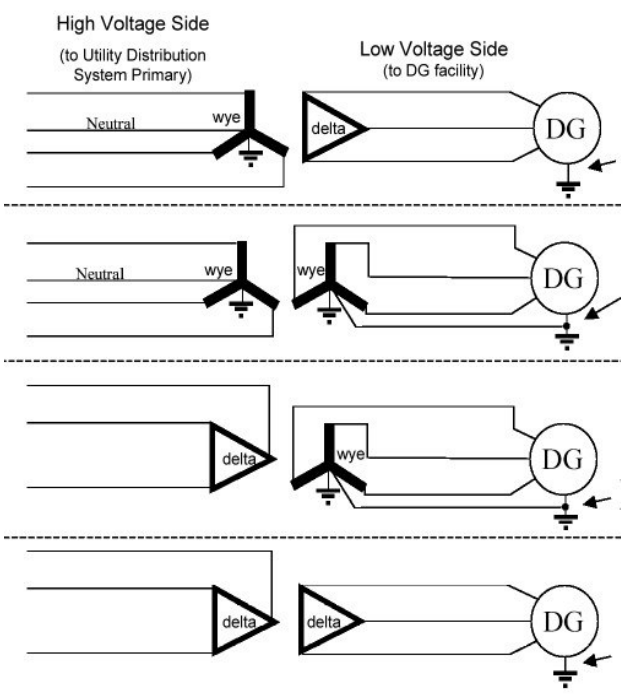

Figure 2. Interconnection Transformer Connections

IV. Generation with ungrounded transformer primary windings

If the DR is connected to the utility by a transformer with an ungrounded primary (delta or ungrounded wye connection); the utility substation transformer may be the only ground current source on the feeder. When a line to ground fault occurs on the utility feeder, the utility breaker may trip with the generator still connected. The resulting system is not effectively grounded. line to neutral voltages on the un-faulted phases approach the normal line to line voltages. This can cause a severe over voltage of line to neutral connected equipment. If the insulation of the connected equipment has not been selected for those voltage levels, the result will be serious damage to the equipment. The connected distribution transformers will become saturated and damaged, insulators and lightning arrestors will likely flash over and the breaker bushings may fail. It is generally accepted that if the connected generator is rated at less than half of the minimum load on the circuit, it will be unable to sustain more than line to ground voltages. Therefore the ungrounded primary connections should only be considered if the distributed generator is rated at less than half of the load on the circuit. If this type of transformer connection is used, voltage relays must trip the DR for an over voltage condition.

V. Loss of primary source to substation power transformer

The loss of primary power to the utility substation transformer(s) means complete loss of the utility supply to the station. As can be shown in Figure 3, primary power can be lost via a switching or interrupting device at the station, or at the remote line terminal breakers. Loss of primary power presents some relaying challenges and introduces some operational issues.

A. Protection for High Side Faults

In Figure 3, the station C transformers isolated via its high voltage disconnect. There is a small section of bus from the high voltage side of the transformer to the isolating device. If there is a possibility of the DR back energizing the transformer, protection must be considered for this bus, in particular for ground faults. This will require the addition of ground fault detection. For situations of this type, it is common to use a ground overvoltage relay on the transmission system to isolate the DR from the fault. Other schemes could involve a transfer trip of the DR whenever the high side disconnect switch is open.

B. Requirements for Line Protection at the Utility Substation

The DR will be a source for transmission line faults. For DRs, where the size of generation is very small compared to the minimum load, line protection may not be required as voltage and frequency collapse (after CBs 1 and 2 are tripped in figure 3) will cause the DR relay protection to operate. Where there is any possibility that the DR will not separate, a transfer trip system from station B to station C or the DR may be required. Some schemes may use under voltage relaying at station bus "C" to detect loss of system source. A thorough analysis of these situations should be done a part of the interconnection study.

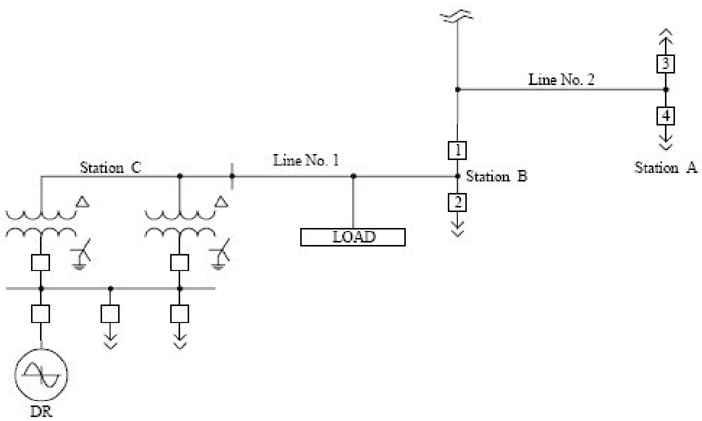

Figure 3. Single Line representation of System

C. System Over voltage Issues

Over voltages can result from transmission line single line to ground faults that are only fed from the utility distribution substation (station C in Figure 3). In extreme cases, line protection tripping at Station B for line no. 1 will have to be delayed to ensure that DR generation is tripped off before the utility breakers are tripped [3].

VI. Fault Current from Distributed Resources

When a DR is connected to a utility feeder, three different systems must be considered for fault currents. These are the utility system without the DR, the combined utility and DR system and the DR alone. It is desirable to maintain proper coordination of relays, reclosers and fuses on the utility system with and without the DR on line. Although the DR would not normally be connected to the distribution feeder without the utility source; this can occur due to sequential tripping during a fault. wye grounded (HV) – delta (LV) transformer can be a source of current for line to ground faults even when the DR is off line. When modeling the impedance of the DR for determining relay operation for fault current, consider the speed of operation of the protective relays. If the protection does not operate in the time frame of the sub transient impedance for the DR the transient impedance may need to be used. This will reduce the current contribution from the DR.

A. Increased Duty

There are three considerations for fault currents. The fault current must not exceed equipment short time ratings. Over current devices must be sized appropriately for the level of fault current. Proper coordination of relays, reclosers, fuses and other over current devices must be based on the available fault current. Depending on the interconnection transformer connection, some or the entire feeder fault current levels will be increased due to the DR. Equipment ratings, such as re-closer withstand capabilities, should be examined as part of the interconnection study.

B. Direction of Power Flow

In many cases, the substation transformer is a much stronger source of fault current than the DR installation. In this case, the fault current from the utility substation will not be significantly decreased for faults between the utility substation and the DR. As long as the current does not exceed equipment capability, this can increase coordination margins between substation relays and feeder fuses. If the DR is between the utility substation and the fault, the DR may cause a decrease in fault current from the utility substation, which needs to be investigated for minimum tripping or coordination problems.

If the DR source (or combined DR sources) is strong compared to the utility substation source, it may have a significant impact on the fault current coming from the utility substation. This may cause failure to trip, sequential tripping, or coordination problems.

VII. Effects on Relay Application and Settings

It is desirable to leave other connected loads and resources largely unaffected by the addition of a DR. At issue is the effect of DR on distribution relay protection, particularly coordination problems.

A. Coordination Problems

The introduction of DR into a system usually designed for serving only load radically causes a number of problems with the protective device coordination. A simple system is depicted in figure 7. An actual system would have numerous load tap along the circuits and may have more than one protective device in the line between the substation and the DR. Any protective devices downstream from the DR will likely benefit from improved coordination from the extra current contribution. Faults between the downstream protective device and the substation will experience reverse current flow in the protective device which can prevent the primary source from clearing the fault unless the protective device is allowed to trip for reverse current before the primary source is re-closed. Consideration for faults on adjacent circuits must take in account the added contribution and in-feed effect from the DR. The circuit feeding the DR will experience reverse flow for these faults and must be coordinated to ensure reliability. Some of these coordination issues are covered in more detail in this section.

B. Relay, Fuse, and Line Recloser

The addition of DR requires that time coordination is maintained between protective devices on adjacent circuits as the effects of DR on coordination is not limited to the circuit to which it is connected. Faults on an adjacent circuit can cause protective devices on the DR circuit to operate. This is undesirable because service can be interrupted to customers who would normally be unaffected by this scenario.

VIII. Voltage and Frequency

In considering the impact of DR on the power system voltage and frequency, it should be recognized that Dr has a greater impact on the system voltage than it does the frequency. This is because it can locally change the voltage where it is applied without having to change the voltage across the entire power system. Whereas, to change the system frequency requires a system-wide impact and so the capacity of the DR needs to be significant relative to the total system capacity. The largest individual DR units (10-50MW) are very less in percent in total

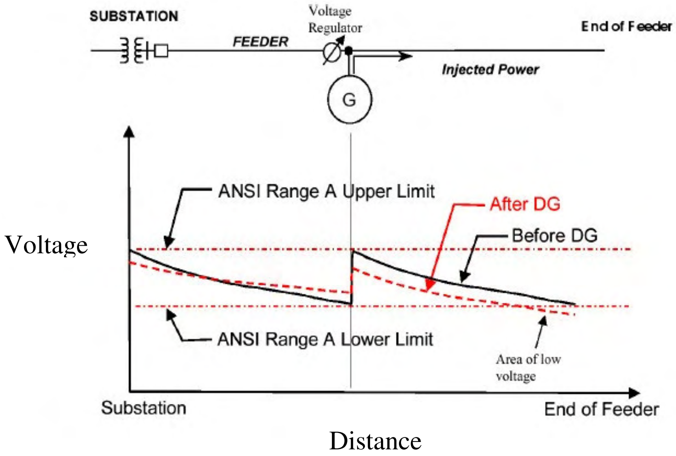

Figure 4. Voltage Regulation

generation so any single DR does not significantly impact frequency.

Maintaining adequate operating voltage at all the customer delivery points is critical to proper system operation. The acceptable range of voltage at the customer end should be +/- 5% on the nominal level, but +/- 6% or +/-8% is also acceptable for occasional or short term events [1].

A. Voltage regulation

As DR units are added to distribution systems and aggregated capacity builds up to a significant portion of total feeder load, coordinating DR with distribution system regulators becomes extremely important. Several possible modes of interaction exist depending on the type of DR and its control configuration. In addition, the presence of DR will directly affect voltage profiles along a feeder by changing the direction and magnitude of real and reactive power flows. The directional characteristics of voltage regulation circuitry must also be considered. In Figure 4, voltage profile on a distribution feeder with distributed resource added near a voltage regulation station is shown.

IX. Sags and Swells

Sags, swells and momentary interruptions are short term variations in system voltage that are usually associated with faults. The switching of large loads or the starting or stopping of motors and other large equipment can also cause sags and swells.

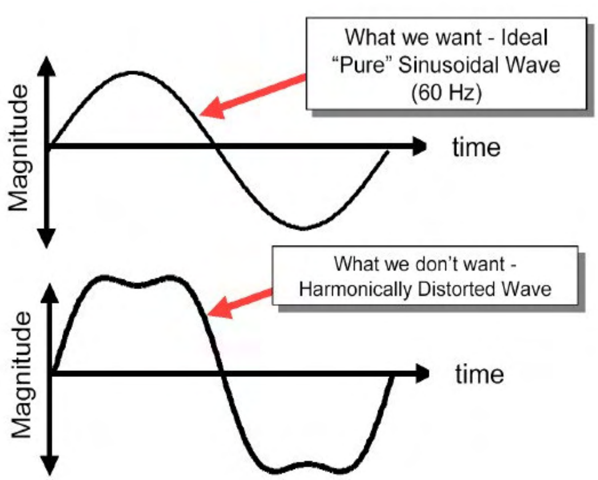

Figure 5. Comparison of pure sinusoidal wave and distorted wave

Sags, swells and other transients have potential to damage extremely sensitive customer equipment in some circumstances. DR can cause such transients if a large capacity unit is turned on all at once, or number of units are turned on simultaneously, or if a resource comes on-line before synchronizing with the grid. These events can lead to out-of-step conditions for rotating equipment that may place undue mechanical stress on the equipment leading to damage.

X. Harmonics

A harmonically distorted wave is one that does not follow a pure sinusoidal pattern as shown in Figure 5. Harmonics are always present on utility systems to some extent. They can be caused by non-linearity in transformer exciting impedance or loads such as fluorescent lights, AC-to-DC conversion equipment, variable-speed drives, switch-mode power equipment, arc furnaces, welders, and other equipment. Installation of DR can, in some cases, increase harmonics on a utility distribution system from acceptable to objectionable levels.

XI. Conclusions

The solution to the problems associated with DR when added in the power network could best be achieve when one has the proper data about the system and proper identification of the problems on the network due to distributed resources. The purpose of the paper was also about the proper identification of the problems associated with DR and power network.

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XIII. Biographies

Umar Naseem Khan was born in 1983 in Pakistan. He received his B.Sc. degree in Electronic Engineering from Ghulam Ishaq Khan Institute, Pakistan, in 2005. After getting more than two years of experience in Electric Power Engineering he enrolled in M.Sc. degree in 'Control in Electrical Power Engineering', Wroclaw University of Technology, Poland, in 2007. Currently with his studies he is also attached with R&D Program in Electric Power Control and Protection with Wroclaw University of Technology and Areva T&D, Poland.

Analysis of cage induction motor smooth start mode with feeding voltage lowering method

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***Abstract*- In the article were presented problems concerning low-voltage cage induction motors direct starting and effects of motors starting with use of most popular voltage lowering methods. There have been pictured advantages and disadvantages of motor starting with use of star-delta switch, soft-start system.**

I. INTRODUCTION

Cage induction motor direct start creates thread flowing from big starting current values, which reach value from 4 up to 8 of rated motor current. Thereupon large voltage drops can occur in supplying system, what is bad on account of industry saturation with precise automatics and informatics. Starting currents cause rising of large electrodynamical forces and release big amounts of heat, what is a frequent cause of windings faults. Maximal power of engines which can be directly put in to urban power network shouldn't be greater than 5 kW, according to norm PN-89E- 05012. If the motors power is greater and it's needed to lower the starting current or cut down starting torque, starting with use of voltage lowering methods is applied. Succession of such solution is lowering of starting current value and starting torque, what derives from theory of induction motors.

II. STARTING WITH USE OF STAR-DELTA SWITCH

Starting with use of star-delta switch (Figure 1.) is a simple and frequently used way of starting small and medium size motors with rated voltage lower than 1 kV.

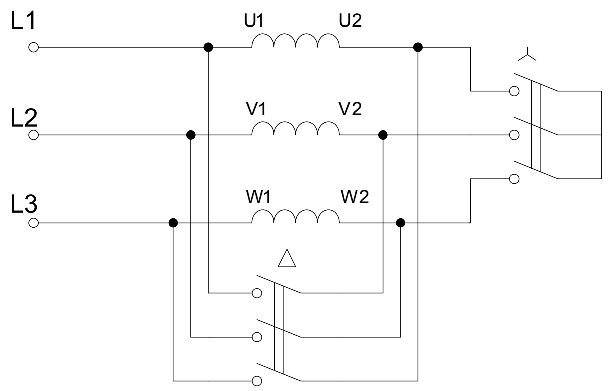

Figure 1. Connections scheme of stator windings during starting with use of star-delta switch.

This kind of start-up is possible only for engines which have got lead out to the terminal board beginnings and ends of stator windings, at rated current the engine has got windings connected in star and at initial state of starting anti-torque doesn't reach more than 20-40% of rated torque. During starting windings are initially connected in star and then, after gaining specified angular speed, are reconnected to delta. During star connection the phase voltage is times smaller than rated voltage. According to equations (1) and (2), which are valid for motors with undersaturated magnetic circuits, a lowering of phase current occurs in comparison to phase current in star connection and lowering of torque about three times [1]. A significant advantage is that current in feeding circuit is three times smaller. To avoid disadvantageous moment and current surges during winding reconnections the angular velocity has to be close to fixed velocity and reconnection time has to be as small as possible. If not the surge current's amplitude can reach value of one during direct start-up.

Earlier recalled relations (1) and (2):

$$I'_r = I_r \cdot \frac{U'}{U_N} \tag{1}$$

where: I'_r – phase value of engine starting current at voltage lowered to U' value, I_r - value of engine starting current for nominal engine voltage U_N.

$$M'_r = M_r \cdot \left(\frac{U'}{U_N}\right)^2 \tag{2}$$

where: M'_r – engine starting torque at voltage lowered to U' value, M_r – engine nominal starting torque for nominal engine voltage U_N.

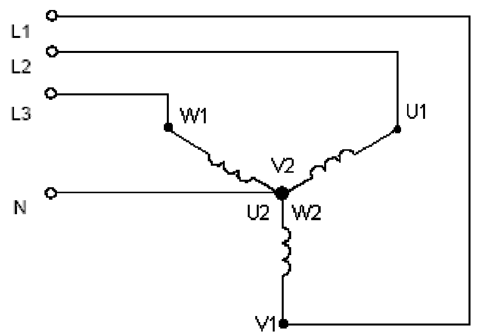

Figure 2. Connections scheme of engine windings in star.

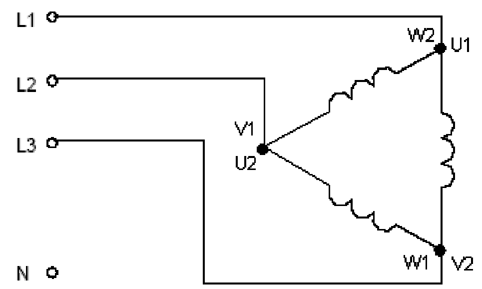

Figure 3. Connections scheme of engine windings in delta.

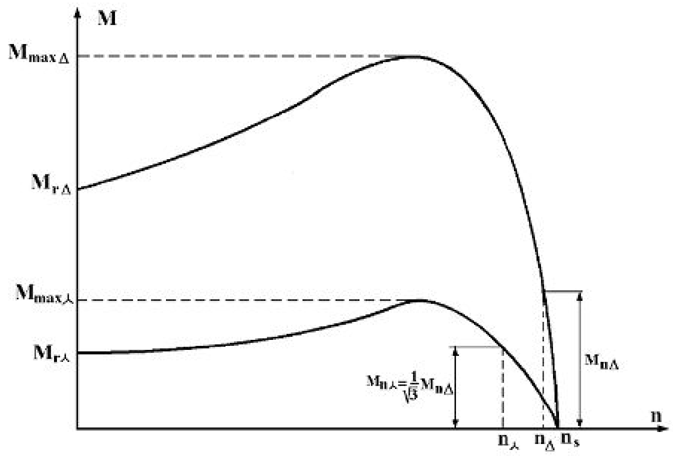

Figure 4. Mechanical characteristic of induction motor before and after application of star-delta switch.

III. STARTING WITH USE OF SOFT-START SYSTEM

Starting with application of thyristor gentle start apparatus is more and more often applied for start-up of small and medium power motors with rated voltage to 1 kV.

Gentle start system limits current and starting torque. This way we can effectively eliminate mechanical overloads and current surges. Cutting off the sinusoid lowers voltage at engine clamps. Basic steering elements used in apparatus are thyristors, power transistors and transistors with isolated IGBT gate.

It's popularity results from easy service, great optimization possibilities and universality. Selection of system is based only on induction motor power. Start-up and setting change is very easy, start-up time, initial starting voltage and coasting time is set with potentiometers according to their individual needs.

The principle of working is based on smooth regulation in time domain of U' engine feeding voltage. Initial value of U' voltage is selected according to anti-torque loading M_O on drive shaft during starting. Engine moment has to fulfill $M' > M_O$, what is the condition to achieve an start-up. Then the system raises voltage linearly up to UN value. After start-up the soft-start system is being shorted. The values of starting current and moment are dependent of growing voltage.

Such solutions have their defects such as considerable apparatus cost and higher harmonic generation [2].

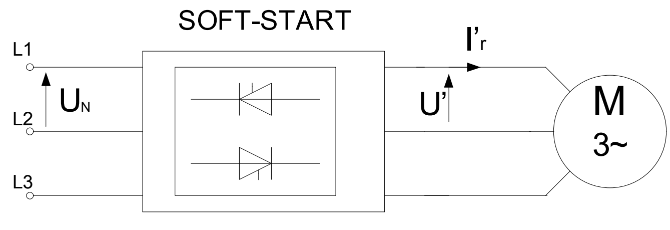

Figure 5. Connection scheme of cage induction motor with soft-start system.

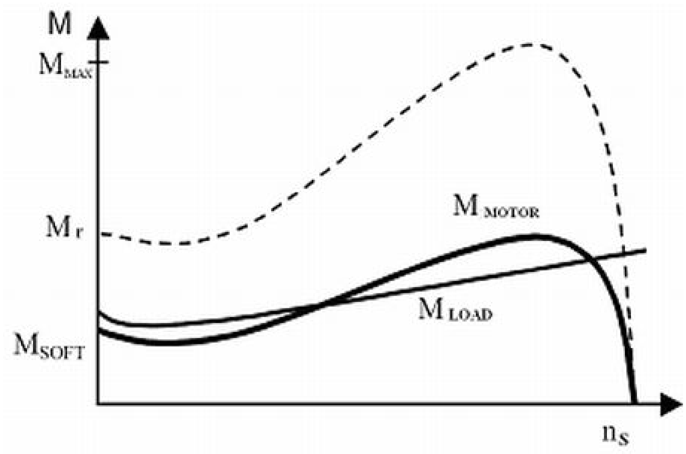

Figure 6. Mechanical characteristic with lowered soft-start voltage.

IV. SUMMARY

Basing on above considerations we can formulate the following conclusions: to build a correctly working power transmission system with cage induction motor we have to analyse the problem of motor start-up in view of correct choice of proper direct start-up effects mitigation method.

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Landshut Wedding 1475

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I. INTRODUCTION

In November 1475 was the wedding between George of Bavaria (son of the Bavarian Duke) and Jadwiga Jagiellon (daughter of King Casimir Jagiellon of Poland). The wedding had a great political importance, because the Bavarian and the Polish established a strong alliance against the Turks.

Today it is one of the largest historical festivities in Europe and well-known all over the World.

II. LANDSHUT

The city Landshut was founded in 1204 by Duke Louis I. 1255 was a split with Bavaria-Munich and Landshut became the capital of Lower Bavaria.

In the first there were a lot of city extensions. The Lower Old Town was established in 1250, the New Town at the end of the 13th and a district called "Freyung" in 1340. A large town fire destroyed a lot of houses in 1342. Nearly 100 of them were destroyed and in the following years they started to construct solid stone houses.

In the 15th century Landshut had his prime age, because it became the political, cultural and industrial centre of Bavaria. The salt trade was the reason why Landshut became richer than Munich.

But with the dead of George of Bavaria Landshut fell into a recession. The war of succession caused the re-union with Bavaria-Munich and Landshut lost his importance.

During the 30 Years' War (1618-1648) there were a lot of pillages in Landshut and that caused famine and pest.

In the early 19th century Landshut had a great revival. The University of Ingolstadt was moved to Landshut and since 1839 Landshut is the seat of the Lower Bavarian government.

Today, Landshut is an attractive business location, because it is close to the Munich airport and the town's landmark is Trausnitz castle [1].

Figure 1. New Town of Landshut

Figure 2. Trausnitz Castle

III. HISTORY

On 10th September 1474 the duke's legation traveled to Poland to conclude the wedding. But they did not come across the king, because he was in a war with Hungary.

Furthermore the marriage contract was decided in Radom on 31th December 1474. On 15th October 1475 the bride transfer was arranged in Wittenberg.

Since 1440 the emperor Friedrich III ruled the Holy Roman Empire's German Nation. Since 1450 Duke Ludwig ruled the Dukedom Bavaria-Landshut. Additionally a power struggle was manifested in England and France at this time period (Wars of the roses & Burgundian Wars).

The Landshut Wedding had a historical influence like no other aristocratic event at this time. In addition the polish empire tried to manifest their power through further weddings. The Christian occident moved together and Poland became an important part of it. Similarly a high level of rivalry remained. Also Habsburg tried to succeed to the crown.

The wedding couple consisted of the bride Jadwiga Jagiellon and the bridegroom George of Bavaria. George of Bavaria was born on 15th August 1455 in Landshut and the day of death was on 1th December 1503. He grew up in Burghausen and at the age of 13, he was integrated in governmental business. Finally he died without any male successor. This was the reason for the war of succession. Jadwiga Jagiellon was born on 21th September 1457 and died on 18th February 1502 in Burghausen. Moreover she was the Daughter of King Casimir Jagiellon of Poland. She delivered five children, but only two survived.

Besides the wedding hat a wide range of guests. For example the guests came from Habsburg, Saxony, Brandenburg, Palatinate, Württemberg and Poland with a big addendum, which based mainly on humans and horses.

The arrival of the bride and the ceremony started at 14th November 1475. For her way to the St. Martins church, the bridge was announced and managed by over 100 trumpeters to the ceremony. After this pompous marriage, the bridal procession made their way through the Old Town to the Town Hall.

Figure 3. the trumpeters

Later on this evening, the emperor Friedrich III kept the bride to the first dance. At the end of this night, attested by witnesses, they brought the bride in a room to her husband. And on the next morning they exchanged their marriage presents.

The hole festivities took 8 days. There were eaten 320 bullocks, 1,500 sheep, 1,300 lambs, 500 calves and 40,000 chickens. Especially for these festivities, 146 cooks worked and created free food for all citizens. Furthermore they made a 32 course wedding dinner. Totally, more than 10,000 visitors came to look for this marriage. Many months before, the goldsmith capacity was very high. Additionally, there was an extra request for 500 armed citizens to protect the wedding community. The costs all in all were about 15 million Euro.

IV. TODAY'S FESTIVITIES

In the year 1903 the citizens copied this wedding for the first time. The highlight for this spectacle was the wedding march with entrance of the wedding couple. In former times, this procession was yearly, today it is every 4 years. In the meantime more than 2000 assistants for the preparation were necessary. Additional events are the camp life, masquerade and the night-plays. The festivities are organized by Landshuter club "Die Förderer e.V.". The next event is planned for June/July 2009 [2].

Figure 4. festivities in 2005

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Der Schengenraum und seine Erweiterung am Beispiel Polen

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I. Einführung

Der Fokus des EEEIC-Workshop liegt in der Auseinandersetzung mit den interkulturellen Beziehungen sowie die Diskussion über die Zukunft in Europa. Im besonderen Blickpunkt stehen dabei auch die geschichtlichen und kulturellen Beziehungen der beiden Nachbarländer Deutschland und Polen.

Dieses Thema wird so auch in der nachfolgenden Veröffentlichung, die sich mit der gegenwärtigen und gleichfalls brisanten Thematik der aktuellsten Erweiterung des Schengenraumes um neun neue, überwiegend osteuropäische Mitgliedstaaten befasst, wieder aufgegriffen.

II. Der Schengenraum und seine Entwicklung

A. Schengener Abkommen – Schengen I

Das sog. „*Schengener Abkommen*“ (oft auch als Schengen I bezeichnet) bildet den Grundstein zum europaweiten Abbau der Grenzen. Es ist nach dem kleinen Moselort Schengen im deutsch-französisch-luxemburgischen Dreiländereck benannt, wo es am 14. Juni 1985 unterzeichnet wurde. Schengen wurde dabei bewusst als symbolischer “Knotenpunkt“ in der Mitte Europas gewählt. Bei diesem Übereinkommen vereinbarten die EU-Mitgliedstaaten Deutschland, Frankreich und die Benelux-Länder einen Verzicht auf Kontrollen des Personenverkehrs an ihren gemeinsamen Grenzen.

Während innerhalb dieses Schengen-Gebietes die Grenzkontrollen wegfallen, wird an den Außengrenzen zu Drittstaaten weiterhin kontrolliert. Zur Unterstützung dessen, wurde ein gemeinsamer computergestützter Fahndungsverbund geschaffen - das “Schengener Informationssys*tem*“.

Wird ein sog. “*Schengen-Visum*“ von einem Mitgliedsland erteilt, besteht auch Aufenthaltserlaubnis und Reisefreiheit in allen weiteren Schengen-Staaten. In Ausnahmefällen, zum Beispiel während internationaler Großveranstaltungen, kann das Abkommen vorübergehend außer Kraft gesetzt und Grenzkontrollen kurzfristig wieder eingeführt werden (zuletzt im Vorfeld des G8-Gipfels 2007 in Heiligendamm).

B. Schengener Durchführungsübereinkommen – Schengen II

Am 19. Juni 1990 unterzeichneten Vertreter der genannten Länder schließlich das „Schengener Durchführungsübereinkommen“, in dem die konkreten Verfahrensabläufe der Umsetzung des Übereinkommens in gesetzlicher und technischer Hinsicht festgelegt wurden.

C. Integration in EU-Recht

Einen weiteren Meilenstein in der Entwicklung des Schengenraumes stellt der sog. „*Vertrag von Amsterdam*“ dar (2. Oktober 1997). Dieser beinhaltet den Beschluss zur Integration des Schengenabkommens in den rechtlichen Rahmen der EU. Die Umsetzung dessen erfolgte schließlich am 1. Mai 1999 mit der Folge, dass alle künftigen EU-Neumitglieder das Schengenabkommen unterzeichnen müssen. Seither sind die Organe der Europäischen Union für die Fortentwicklung des Schengener Rechts verantwortlich, ohne dass dieses jedoch notwendigerweise in allen Mitgliedstaaten gilt.

D. Erweiterung der Schengen-Staaten um acht osteuropäische Länder und Malta

Am 21. Dezember 2007 erfolgte schließlich die jüngste Erweiterung mit der Implementierung des Abkommens in den 2004 beigetretenen EU-Ländern durch Öffnung der Land- und Seegrenzen in Estland, Lettland, Litauen, Malta, Polen, der Slowakei, Slowenien, Tschechien und Ungarn.

Im Zuge dieser Grenzöffnungen wird derzeit die Fertigstellung des neuen “*Schengener Informationssystems II*“ (Erweiterung der Fahndungsmöglichkeiten durch zusätzliche Speicherung von Biometriedaten, Fingerabdrücken und Lichtbildern) vorangetrieben [1]-[4].

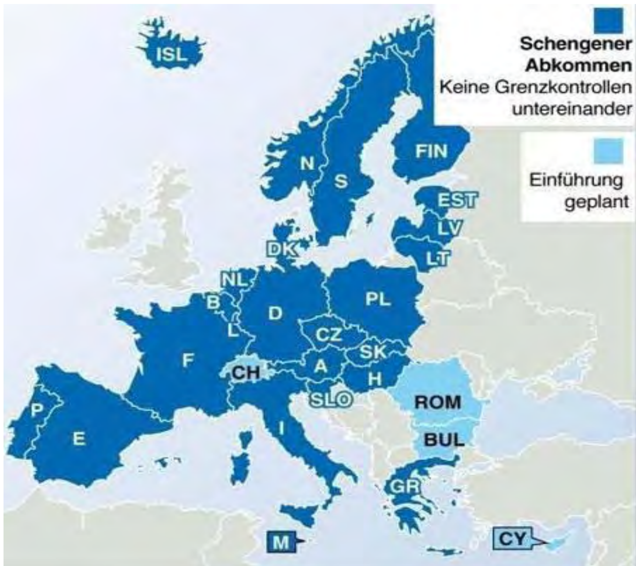

Abbildung 1. Die Staaten des Schengener Abkommens [2]

III. Die aktuelle Erweiterung – Neumitglied Polen

Dreißig europäische Staaten haben das Schengener Abkommen inzwischen unterzeichnet. Es wird nach mehreren Erweiterungen in mittlerweile 24 dieser Unterzeichnerstaaten durch Abschaffung der Grenzkontrollen faktisch angewandt. Bis auf Island und Norwegen handelt es sich dabei um EU-Mitgliedstaaten. Das Vereinigte Königreich und Irland, als Vertreter der EU-Länder, nehmen am Abkommen allerdings nur eingeschränkt teil (nur Strafverfolgung und polizeiliche Zusammenarbeit; kein Wegfall der Passkontrollen). Nach seiner jüngsten Erweiterung besitzt der Schengenraum nunmehr eine Größe von annähernd 3,6 Millionen Quadratkilometern mit rund 400 Millionen Einwohnern.

Presseveröffentlichungen vor dem 21.12.2007 zeigen die Ängste und Befürchtungen der betroffenen Bewohner in der Grenzregion auf.

„Wird Deutschland jetzt unsicher?"[5], „Die Angst vor der Freiheit" [6] sowie „Am Rand des Reichtums" [7] sprechen für eine unsichere Zukunftsaussicht und Furcht vor einem Anstieg der Kriminalität, aber auch für die Angst vor dem Ungewissen und der neuen Freiheit. Positive Äußerungen sprechen von „[...]einer zunehmenden Investorenanfrage an der Neiße" und davon, dass die „Grenzregion attraktiver wird" [8].

Einige Tage nach Öffnung der Grenzen finden sich erneut geteilte Standpunkte in der öffentlichen Presse wieder. Auf der einen Seite wird publiziert: „Kein Anstieg der Kriminalität aus Osteuropa" [9] sowie „Kriminalität an polnischer Grenze steigt nicht" [10]. Dennoch veröffentlichen die gleichen Herausgeber Artikel, wie „Tschetschenen nutzen neue Grenzfreiheit" [11] und „Illegale Einreisen nach Deutschland nehmen zu" [12]. Dies bestätigt die Besorgnisse und Verwirrung der Bevölkerung, da sich die vielen öffentlichen Meinungsäußerungen oft widersprechen.

TABELLE I
Umfrage zum Grenzwegfall nach Osteuropa [13]

Umfrage:	(Aktuell: 2981 Stimmen)
Seit Mitte Dezember gibt es an den Grenzen nach Osteuropa, etwa zwischen Deutschland und Polen, keine Kontrollen mehr. Was halten Sie davon?	
55%	Ich habe jetzt Angst vor mehr Kriminalität
20%	Ich freue mich – Europa wächst zusammen
22%	Ich denke, dass sich Chancen und Risiken die Waage halten
4%	Das ist mir egal

In einer Umfrage der Zeitung "Die Welt" ist diese Besorgtheit der deutschen Bevölkerung deutlich wieder zu erkennen. Mehr als die Hälfte der Stimmen sieht dem Grenzwegfall mit Befürchtungen entgegen, während sich nur 20% der Stimmen Zuversichtliches von der neuen Grenzregelung erhoffen. Besonders das große Wohlstandsgefälle dies- und jenseits der Grenze trägt nicht besonders zur Bildung des „subjektiven Sicherheitsgefühls" auf der deutschen Seite bei. Die Umsetzung der guten Ideen von Schengen lassen den Bürger Westeuropas zweifeln und verlangt Zeit und Erfahrung, um eine glaubwürdige und verlässliche Akzeptanz der Veränderungen zu erreichen.

IV. Der zukünftige Schengenraum – Europa "ohne Grenzen"?

Noch in diesem Jahr kommt es zu einer weiteren Ausweitung des Schengenraumes. Im November 2008 treten die Schweiz sowie das Fürstentum Lichtenstein dem Abkommen bei. Hinsichtlich des Sonderstatuses der Schweiz innerhalb der EU werden die Neuregelungen im Bezug auf die justizielle Kooperation, gleichsam wie in Island und Norwegen, auch ohne EU-Mitgliedschaft angewendet. Eine explizite Unterzeichnung des Abkommens von Lichtenstein gibt es allerdings nicht, da sich der Staat bereits in Zollunion mit der Schweiz befindet und schon gemeinsame Grenzkontrollen durchgeführt werden. Voraussichtlich 2009 wird ebenso Zypern dem Schengener Abkommen beitreten. Weitere Schritte zur Implementierung zusätzlicher Staaten in Europa, wie Rumänien und Bulgarien werden aufgrund noch fehlender Reformschritte und einer vorerst probeweisen Mitgliedschaft der EU allerdings frühestens 2011 eingeleitet.

Die neue Reisefreiheit ohne Grenzkontrollen innerhalb der Schengen-Staaten bringt auch neue Verpflichtungen der Mitglieder mit sich. Die Außengrenzen des Schengen-Gebiets werden umso stärker bewacht, was zu einer Abschottung nach außen führt. Durch die Verschärfung der Einreisebedingungen können Menschen aus Ländern, deren Nachbarstaat zum Schengenabkommen gehört, ohne ein Schengen-Visum plötzlich nicht mehr einreisen. Flüchtlinge hatten früher die Möglichkeit, in unterschiedlichen Staaten Asyl zu beantragen. Durch das Abkommen gibt es nun nur noch die Möglichkeit, in einem Staat einen Asylantrag zu stellen. Bei einer Ablehnung des Antrags muss gegenwärtig der Schengenraum verlassen werden, was gewiss zu einem Anstieg der illegalen Einwanderungen führen wird.

Durch das Abkommen vergrößert sich das Wohlstandsgefälle zwischen Mitgliedern und außenstehenden Staaten. Bürger- und Menschenrechtsinitiativen werfen den europäischen Industriestaaten aus diesem Grunde vor, dass die Grenzregelungen auf der einen Seite zur Sicherheit und zum Wohlstand der reicheren Staaten beitragen, dies aber auf Kosten von Flüchtlingen und den Menschen in Armut geschieht.

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Solar energy and climate in Poland

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Article show basic information about solar energy, type of systems, technologies and condition to use solar systems in Poland.

I. INTRODUCTION

The solar energy gets-from solar radiation. Maximum energy which we can get on one square meter is about 1370 W/m^2. It's solar constant which characterize radiation from upper layers of atmosphere. In result reflection and absorb a part of energy, we can get 1000-1200 W/m2.

At present day the most popular way of conversion solar radiation to electric energy are photovoltaic cells. Cells are composed from semiconductor. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. Cells produce a few mW to few W. The most popular devices where we find photovoltaic cells is small electronics e.g. calculators, watches. If we would produce more amount of energy (e.g. to heat house), it applies photovoltaic panels. Among solar collectors are distinguished three groups: flat, evacuated tube and converging**.** Typical flat collector consist of transparent layer, absorber and therm (the most popular are cooper tubes) and insulation. Efficiency of collector, drop simultaneously with growth of temperature between environment and material.

Solar collectors are used the most often to: heat up water, heat up basin's water, and aid central warming. The most serious problem isn't ability to produce energy, but store energy and use it in right time.

II. BASIC SYSTEMS AND EFFICENCY

At discuss about solar collectors we must mention about three basic configurations about photovoltaic systems: free-standing, connecting to system, and hybrid.

Free-standing system base on using only energy from photovoltaic cells. Those systems consist of photovoltaic panel, accumulator and device which control a level of charge in accumulator. Accumulator must have a large capacity, because delivering energy must be secure during cloudy weather or night.

Hybrid's system consists of photovoltaic panels and other system which produce energy (e.g. gas generator, wind generator). For insure suitable efficiency, are apply the much more complicated combination than cause of free standing system.

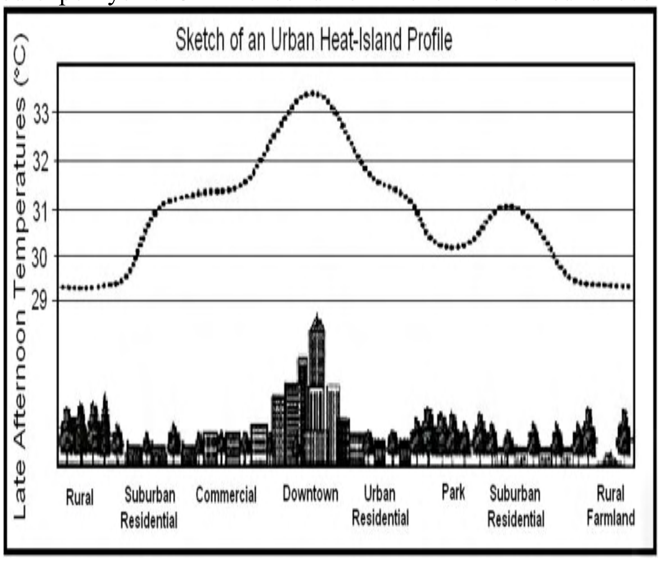
Efficiency of system is depended on solar radiation. The most popular small systems have ratio of proficiency about 30%-60%. Professional free standing systems have low ratio, about 20%-30%. Cause of this situation is mode of working. They work the whole year at constant load, and modules must be suitable large. If we must assure provide energy during winter, unfortunately we are forced to waste a large part of energy. Hybrid's systems have much higher ratio of proficiency (about 50%-70%). It results from fact, that system can be supported by generator. Photovoltaic generator to stand out the best efficiency, because energy is used on place or transmitted to net. System which co-operate with high quality chopper can reach even 80% of efficiency.

The serious problem which limited application those system are high cost of investment. In effect price of solar energy continuously can't rival with conventional sources. Despite it, countries in European Union, USA and Japan do intensive research. Very probably is that renewable energy source will be much more popular in nearest future than present time.

III. CLIMATE CONDITION IN POLAND

In Poland exist well condition to produce energy from renewable sources like solar energy. From climatic respects can't be use only high-temperature technologies. The most important coefficient describe this problem, is amount of falling radiation on unit of area.

The annual dense of radiation in Poland on flat area include in range 950-1250 kWh/m2. Average insolation it 1600 hours per year. Climate condition are characterized uneven



distribution of solar radiation during year. 80% whole energy to fall per six months (period since April to end of September). During the summer sun activity it about 16 hours, i nwinter it's only 8 hours.

The most convenient area in Poland in respect solar radiation is southern part of Lubelskie Province. The central part of contry (about 50% whole area) has insolation at level 1022-1048kWh/m2 per year. Southern, eastern and northern part of Poland – 1000kWh/m2 and less. The least convenient condition for solar energetic current on Silesia and border with Czech Republic, Germany and Poland ("Black Triangle", this area gets so nickname, because there are very polluted air).

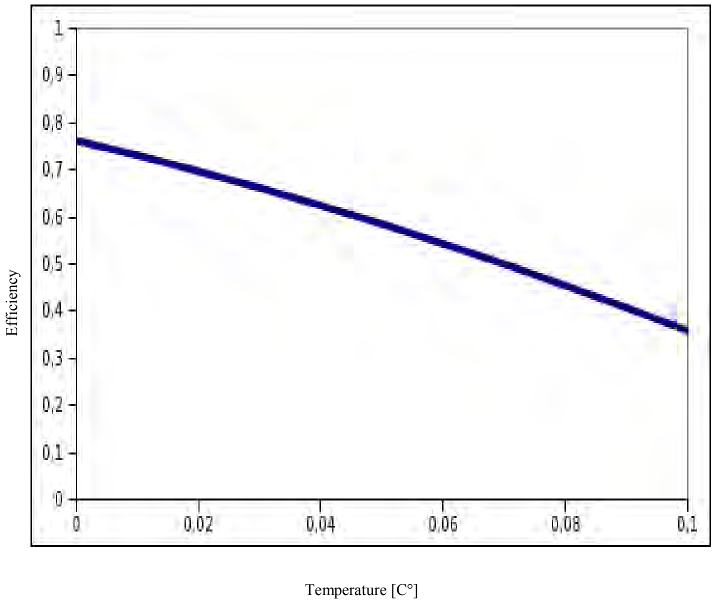


Figure 1. Efficiency as a function of reduced difference of temperature between material and environment.

Weakly insolation areas are also coast, except Wybrzeże Zachodnie. Northern borders gets about 9% less energy than southern areas. Despite it, seaside has the most clear atmosphere.

IV. SITUATION ON THE WORLD

What is situation on the world? In USA and Canada predominate basin absorbers about magnitude 17, 9 GWth. In China, Europe and Japan appear mainly flat collectors, used to heat up water. In 2003 year the most collectors for 100 000 inhabitants were in Cyprus, Austria, Greece. The fastest improve of market was noticed in China, New Zeeland, Australia and Europe. Very important role in solar energetic has Asia. China produce the most collectors, Japan has a very serious position in respect produce photovoltaic cells. In Europe very important is German's market.

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Introduction to Hill Climbing - practical analysis

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I. Introduction

The name of technique describe for what we can use this technique – to find local maximum of given function. In order to get to a peak we need to climb toward it. In this article I intent to present how to recognize problem in which this technique could be effective and how hill climbing could be used to find optimal solution, especial for Non Polynomial time class problem. I will try to present step-by-step how to project hill climbing algorithm with a few practical examples.

II. General idea

For any solution hill climbing algorithm pseudo code will look like this:

```
solution = generateAnyValidSolution()
score = evaluateScore(solution)
do
      newSolution = correctSolution(solution)
      newScore = evaluateScore(newSolution)
      if (score < newScore)
              score = newScore
              solution = newSolution
while (score < newScore)
```

As we can see to find solution we have a few steps to design: creating any valid solution, evaluation of "score" for respective solution, and correction method. Every part of algorithm we must consider separately.

III. Generating starting solution

This part of our algorithm sound is the most intuitive. We should get any solution for our problem. But we must remember that this is starting point for our algorithm and by hill climbing we only get the closest local maximum. Question is how to start climbing for global maximum. Answer is simple: starting point should be on the slope leading to global maximum. This problem cannot be answered directly because it heavily depends on problem to solve. Good thing to do is to try a few different approaches and simply test which one give us good starting point for specific problem or even run hill climbing algorithm several times from various starting points and see which one will generate better answer for our problem. For now let's assume that our problem deal with finding permutation. Most problems where this technique is applicable deal with finding optimal combination of some elements. Regardless of problem we should obtain a state vector which describe valid solution for our problem.

IV. Solution correction

Solution correction is core of our hill climbing algorithm. It is here where we climb toward local maximum of our function. We have some solution for our problem X. Depending on what X represent we can correct it by looking if small change to any component of X would create better solution. Most often hill climbing technique try to set every component to it's all possible values and leave the one which give the biggest gain.

An example is looking for best configuration of our state vector X elements. While we have n! combination we are able to check it in sensible time but only for small n about 10. But we never are able to check it for n equal 100. If we assume that our computation time is equal c we can do some simple analysis:

$$\begin{aligned} &n = 10 \\ &t = c \cdot n! = c \cdot 10! = c \cdot 3628800 \\ &\mathrm{n} = 100 \\ &t = c \cdot n! = c \cdot 100! \approx c \cdot 9{,}33 \cdot 10^{157} \end{aligned} \tag{1}$$

We can clearly see that even for very small c we never get our best solution in sensible time for big n. But if we have any permutation we can try to correct it by check which swap of two components will give us the biggest gain in score evaluation of our solution. In comparison with general solution checking all swaps will take:

$$\begin{aligned} &n = 10 \\ &t_{HC} = c \cdot \binom{n}{2} = c \cdot \frac{(n-1) \cdot n}{2} = c \cdot 45 \\ &\mathrm{n} = 100 \\ &t_{HC} = c \cdot \binom{n}{2} = c \cdot \frac{(n-1) \cdot n}{2} = c \cdot 4950 \end{aligned} \tag{2}$$

As we can see it won't take that much time. Also we greatly reduced amount of time, especially for big values of n. Of course we should remember that it's time for one iteration of our algorithm, and general solution for checking all possibilities will return the best answer after one iteration. But even for small n we can get interesting conclusion. For n equal 10 one iteration of general algorithm which would check all possible permutation would be sufficient. How much iteration can we perform if we don't want to exceed general solution time? We can roughly calculate ratio of time for both approach as upper limit of iteration for hill climbing algorithm so it's would be worth to use it. Lets again assume that n = 10:

$$i = \frac{t}{t_{HC}} = \frac{c \cdot 3628800}{c \cdot 45} = 80640 \tag{3}$$

As we can see even for small n we can iterate our method many times before we take comparable time to general solution.

V. Evaluation of score

By evaluation of score we should understand measurement of how good our solution is. A particular example of score function depends on specific situation. In general form we can write it as a standard weighted sum of gains minus costs:

$$score(X) = \sum_{i}^{n} \alpha_i \cdot gain(\overline{X}) - \sum_{j}^{m} \beta_j \cdot cost(X) \tag{4}$$

While general form look nice we should remember that there are situation where linear weighted dependency of costs and gains isn't sufficient to properly measure how good our solution is.

VI. Drawbacks

If we consider problem dealing with finding optimal permutation generally it work's pretty well if our state variables don't depend on each other. But in case they do the score variation can be very high and we won't be able to improve our solution even a little bit. There can be many local maximum and if we check only one starting point efficiency of our algorithm won't be much better than a random solution.

Dangerous situation can appear if movement in any direction won't change our score. The worst situation is when this happen at the starting point of our algorithm, because it does nothing. Therefore it is recommended to select a few starting point and run our algorithm several times to avoid such situation.

VII. Classical example

The classical problem which can be solved by this technique is traveling salesman problem. For start we will deal with the simplest version: We have to sell our goods to n customers that are scatter around city. We start our journey from our magazine and we want to return there when deliver is finished. Question is how to visit every customer if we want to minimize our travel distance. Let's assume that we have many customers, more than 100.

Simple analysis of this problem in (1), for n = 100 shows that we are unable to solve this problem simply by checking all available permutation of our clients. So we will try to solve this problem by hill climbing. To do this we will consider separately every steps of this algorithm described above:

Any valid solution would be any combination of our clients. That would be sufficient. However if we think for a moment we can try some different approach to find better solution for starting point. Many customers can be close to each other so we can very simply find much better starting combination: first select the closest client to our magazine, next choose the closest one to our actual position and so on.

Evaluation of score for this problem is simple. Our cost is equal to the whole path length and can be easily computed as a sum of all path lengths.

Solution correction can be done simply by checking which swap of two customers will shorten path most.

Almost always there is place for further development of HC algorithm. For this problem we can run our algorithm several times with random starting permutation and save the best optimal solution returned by our HC algorithm.

VIII. Another example

Now let's consider another problem: we are owner of restaurants network and we want to build about 20 new one in a city which doesn't have any of them. But we cannot build it where we want. However we check for possible locations and have about 100 places that we can buy and place our business. The problem is which location we should place or restaurants in. We want to minimize the distance from any point of our city to the closest restaurant. For simplification we assume that population density is constant.

Any valid solution could be simply randomly selected 20 places to run restaurants. It would be good for start, however we can later improve this by trying to distribute our starting points more uniformly around the city.

Evaluation of score will be done by a little heuristic. If we know our city dimension we can simply sum path lengths to the closest restaurant for some points distributed uniformly on city. The only problem is to find optimal density for our points so that the computation time won't be too big and the given sum would be representative.

Score correction would be swapping our first restaurant to any of free points and save the point which return the best score. Then we check second one and so on.

For final analysis we should understand what this algorithm does. If we start with some set of random selected points then checking the sum of path lengths will move points close to each other and distribute it more uniformly for a given set of possible location on the whole city. After that it will only move them a little bit just to optimize our score function. And finally there will be a point in which any change of any restaurant location wouldn't improve our score and that will be our optimal or even best solution.

The Unexploited Wind Energy Potential – a Brief Introduction to Offshore Wind Farms

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***Abstract*-** **The goal of this review is to look closer at the world's wind power potential with respect to offshore wind farms and to present briefly an introduction of today's multimegawatt class turbines used in power generation. Also some economical aspects like distribution of costs for Offshore and Onshore wind farms will be talked over.**

I. INTRODUCTION

As we all know, each year a demand for an electricity is higher due to the progress of civilization: economic and technological development. Respectively, the wind power available in the atmosphere is much greater than current world energy consumption.

The available wind energy estimates range from 300 TW to 370 TW [1]. Using the lower range, 5% of the available wind energy would be enough to cover worldwide energy needs. To date, the most comprehensive study [2] has found the potential of wind power on land and near-shore to be 72 TW, it is equal to 54,000 MToE (million tons of oil equivalent) per year, or over five times the world's current use in all forms. The rest of remaining potential is located in the oceans.

Most of this wind energy is available over the open oceans, since they cover 71% of the planet. The oceans make an ideal location for wind turbines because they are windy all over. The ocean's surface isn't littered with hills, trees and houses like the land is, so winds over the water are faster because there is less friction to slow them down [3]. It is also worth remembering that the roughness of the surface it is not without significance. The water has less surface roughness than the land, especially the deep water. Thereby the average wind speed over the water is usually considerably higher in the lower parts of the air.

The wind power has become an increasingly attractive option for generating clean energy and reducing greenhouse gas emissions for several countries. The Offshore wind farms in Denmark, Germany and the United Kingdom are now used to generate the electricity, with Denmark drawing 20 percent of its energy from the wind power.

By 2010 [Fig.1], the World Wind Energy Association expects 160GW of capacity to be installed worldwide [4], up from 73.9 GW at the end of 2006, implying an anticipated net growth rate of more than 21% per year.

Different forecasts and measurements studies [Fig.2] indicate that there is a lot of potential for exploiting offshore

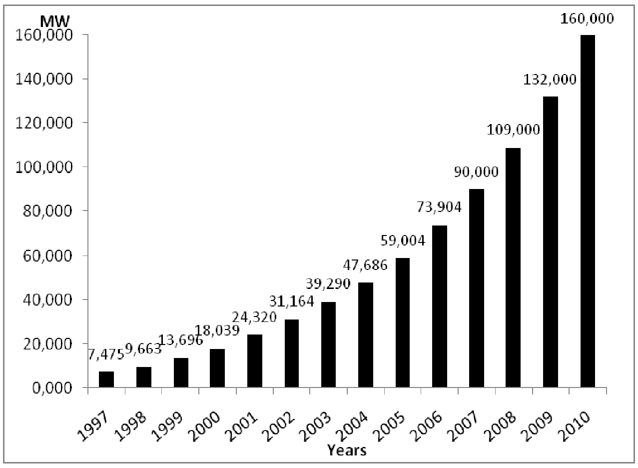

Figure 1. World Wind Energy – Total Installed Capacity (MW) and Prediction 1997-2010.*

wind energy. But the forecasts show a wide variation because technological and economic viability is still uncertain. Besides, numerous other interests (shipping, fishing and nature conservation) all have the effect of reducing the calculated potential in practice.

II. OFFSHORE WIND TURBINES

There is a considerable interest in using wind turbines offshore and some European countries have set targets for the installation of the offshore wind turbine capacity. Sitting of the wind turbines offshore is partly attractive because of the higher wind speeds over the sea but mainly because of the reduced environmental impact. The two main restrictions on the sitting of the wind turbines on land are visual impact and noise. Both of these problems can be avoided by locating turbines some distance offshore [5]. This wind farms zones are generally considered to be ten kilometers or more from the land. It can be taken as a virtue because they would be less obtrusive than turbines on the land, as their noise and size can be reduced by the distance.

The main disadvantage of the offshore sitting is higher expense. The installation is more expensive than onshore due to the materials and additional expenditures. The tower itself is generally taller once the submerged height is included. Therefore they typically stand on towers that have to be driven deep into the ocean floor. With current technology this

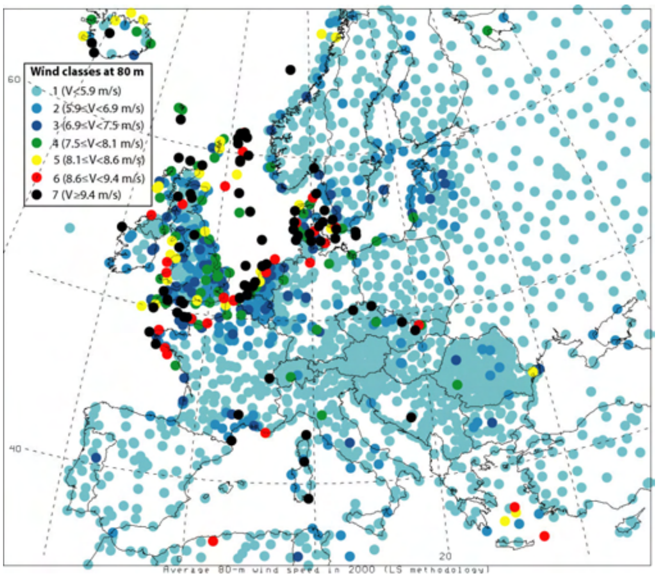

Figure 2. Wind speed classification at 80m above the land in Europe.

arrangement only works in water depths of about 20 to 30 meters. Otherwise, it is too difficult to erect the metal pole that the turbine will be placed on. However, experimental turbines have been built out to a depth of 50 meters off the coast of Scotland. These types of turbines may be in commercial use soon [3].

III. Great Potential in Europe

The North Sea and Baltic regions will play a central role in the utilization of the offshore wind energy [Fig.2].

First, the onshore use of wind energy has already progressed farthest in these regions, which means land sites are increasingly occupied. (e.g. The United Kingdom plans to use offshore wind turbines to generate enough power to light every home in the U.K. by 2020 [7]).

Second, wind energy will become competitive more quickly in northwestern Europe because of the comparatively high cost of electricity at the international level.

Third, the North Sea and the Baltic are rather shallow and close to large population centers, making them very suitable for this form of energy. The development of offshore wind power consequently promises significant prospects for exporting the electricity to neighbouring countries and offers a potential development for offshore ports [8].

Forth, the producers are constantly trying to do the more powerful generators, thereby the costs of the turbines are slowly decreasing and they are becoming more available.

IV. Economical Aspects

The Operation & Maintenance of offshore wind farms is more difficult and expensive than for equivalent onshore wind farms [8]. The offshore projects initially require higher investments than onshore due to turbine support structures and grid connection. The cost of grid connection to the shore is typically around 25% - much higher fraction than for connection of onshore projects. The other sources of additional cost include foundations (up to 30%), operation and maintenance (with expected lower availability) of turbines.

It is not without importance that the water depth and distance to the shore can have a significant impact on redistributing the costs. Note that the O & M costs are excluded and these will probably typically amount to around a quarter of the production costs. The similar magnitudes of cost for several different components (wind-turbine, support structure, power collection & transmission and O & M) emphasis the importance of an integrated approach to the design of the whole wind farm development.

V. Summary and Conclusions

It would seem that the current optimism about the offshore wind energy has a firm basis, in currently available technology, in likely reductions in costs and of equal importance, in the general widespread public and European Union's support and the generally low impact on the environment. The experience of the first prototype offshore wind farms has proven the technical viability and the large-scale developments currently being undertaken will provide us with the significant amount of the energy [9]. We can take the WWEA [4] data as the confirmation of the hidden potential for the wind. It tells that at end of 2007, the worldwide capacity of wind-powered generators was 94.1GW and that is more than the predictions.

TABLE I
High-Performance Turbines Developed by Different Producers

Producers	GE Energy	BARD	Vestas	RE	Enercon	Multibrid
Rated power [MW]	3.6	5.2	4.5	5.0	4.5	5.0
Generator	Ad[a]	Ad[a]	A[a]	Ad[a]	S[a]	S[a]
Rotor diameter [m]	104	122	120	126	114	116
Top head-mass [t]	295	375	210	410	500	310
Rated wind speed [m/s]	13	13	12	12	12	12
In operation since	'04	'04	n/a	'04	'02	'04

[a]Ad – Asynchronus double fed, A[a] – Asynchronus, S[a] – Synchronus

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BIOGRAPHY

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Application of thermal imaging in electrical equipment examination

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Abstract- **The paper states about applying thermal imaging measurement methods to electrical equipment diagnostics. Modern infrared mapping techniques allow to take fast and non-exhausting measurements of devices that are not easy accessible or where measurements are dangerous to humans. Thermography has found it's principal use in power engineering in diagnostics of electrical apparatus and equipment, mainly transformers and insulators.**

I. BASIC IDEA OF THERMAL IMAGING

Thermography, also called thermal imaging, is a type of infrared imaging. Infrared radiation is electromagnetic radiation of a wavelength longer than visible light wavelenght, but shorter than that microwaves. It's name means "below red", because of red being the color of visible light with the longest wavelength. Infrared radiation has wavelengths between about 750 nm and 1 mm, spanning five orders of magnitude. Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900–14.000 nanometers or 0.9–14 µm) and produce images of that radiation [2]. Wien's displacement law is a law of physics that states that there is an inverse relationship between the wavelength of the peak of the emission of a black body and its temperature (Figure 1). Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermography makes it possible to see environment with or without visible illumination.

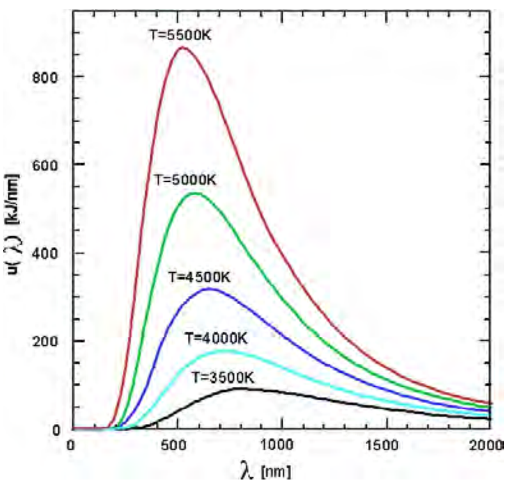

Figure 1. The wavelength corresponding to the peak emission in various black body spectra as a function of temperature

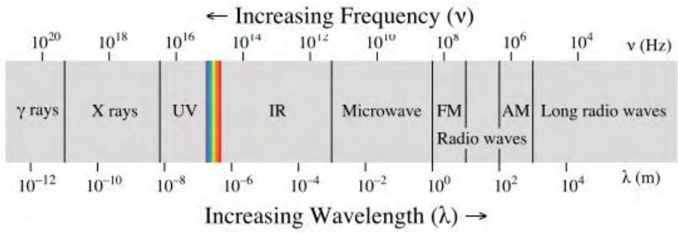

Figure 2. Electromagnetic spectrum

The amount of radiation emitted by an object increases with temperature, therefore thermography allows one to see variations in temperature. When viewed by thermographic camera, warm objects stand out well against cooler backgrounds; humans and other warm blooded animals become easily visible against the environment, day or night.

II. THERMOGRAPHIC CAMERAS

A thermographic camera, sometimes called a FLIR (Forward Looking InfraRed), or an infrared camera less specifically, is a device that forms an image using infrared radiation, similar to a common camera that forms an image using visible light. Instead of the 450–750 nanometer range of the visible light camera, infrared cameras operate in wavelengths as long as 14,000 nm (14 µm) (Figure 2). Cameras create a thermal image of observed target, generally in scale from black (coolest) thru red to white (hottest), and also provide on the image a reference scale. Thermographic cameras can be broadly divided into two types: those with cooled infrared image detectors and those with uncooled detectors [3].

Cooled detectors are typically contained in a vacuum-sealed case and cryogenically cooled. This greatly increases their sensitivity since their own temperatures are much lower than that of the objects from which they are meant to detect radiation. Typical cooling temperatures range from 4 K to 110 K, 80 K being the most common. Without cooling, these sensors (which detect and convert light in much the same way as common digital cameras) would be 'blinded' or flooded by their own radiation. The drawbacks of cooled infrared cameras are that they are expensive both to produce and to run. Cooling and evacuating are power- and time-consuming. The camera may need several minutes to cool down before it can begin working. Although the components that lower temperature and pressure are generally bulky and expensive, cooled infrared cameras provide superior image quality compared to uncooled ones.

In principle, superconducting tunneling junction devices could be used as well as infrared sensors because of their very narrow gap. Their wide range use is difficult because their high sensitivity requires careful shielding from the background radiation.

Uncooled thermal cameras use a sensor operating at ambient temperature, or a sensor stabilized at a temperature close to ambient using small temperature control elements. Modern uncooled detectors use sensors that work by the change of resistance, voltage or current when heated by infrared radiation. These changes are then measured and compared to the values at the operating temperature of the sensor. Uncooled infrared sensors can be stabilized to an operating temperature to reduce image noise, but they are not cooled to low temperatures and do not require bulky, expensive cryogenic coolers. This makes infrared cameras smaller and less costly. However, their resolution and image quality tend to be lower than cooled detectors. This is due to difference in their production processes, limited by currently available technology.

Specification parameters of an infrared camera system are number of pixels, spectral band, sensor lifetime, MRTD (Minimum Resolvable Temperature Difference), field of view, dynamic range, input power, mass and volume.

III. THERMAL IMAGING SUMMARY

Advantages:

•You get a visual picture so that you can compare temperatures over a large area

•It is real time capable of catching moving targets

•Able to find deteriorating components prior to failure

•Measurement in areas inaccessible or hazardous for other methods

•It is a non-destructive test method

Disadvantages:

•Cameras are expensive and are easily damaged

•Images can be hard to interpret accurately even with experience

•Accurate temperature measurements are very hard to make because of emissivities

•Most cameras have ±2% or worse accuracy (not as accurate as contact)

•Training and staying proficient in IR scanning is time consuming

•Ability to only measure surface areas

Thermal imaging requires special skills from service staff. Persons directed to use it have to be trained at special courses to get proper knowledge on cameras working conditions, investigated equipment materials and thermal imaging itself. Well trained staff and high quality camera are a must to obtain good pictures.

IV. APPLICATIONS IN POWER ENGINEERING

One of the common application of thermal imaging in power engineering is examination of power transformers. They can be examined during normal working conditions. Many defects are better visible when transformer isn't switched off, like overheating or cold parts, which would be harder to find with normal inspection methods.

Figure 3. Image of an high voltage transformer

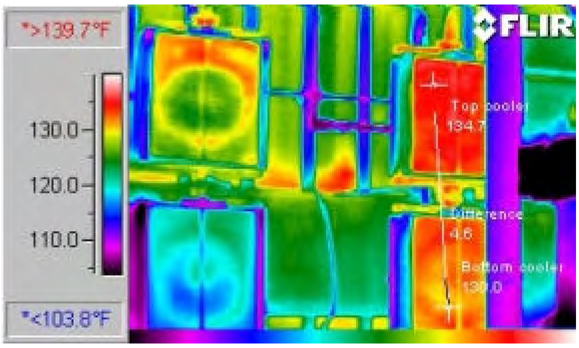

Figure 4. Transformer radiators seen by thermographic camera

This infrared image shows transformer wall with radiators on it (Fig.3). There can be seen a cold radiator on the lower left, possibly due to a bad pump. This could be a serious problem as the capacity of the transformer is reduced and other radiators will work above their nominal working temperature.

Thermal imaging finds it's best application in inspections of insulators and arresters. During normal operation conditions their testing would be dangerous and switching off the line or whole installation very costly [1].

Figure 5. Intermediate station class arrester

Figure 5. Intermediate station class arrester seen by thermographic camera

Retaining type of medium voltage arrester is used on the distribution side of a substation on three phase feeder lines at the substation to hold the lines (Fig.4). The heating problem with these arresters could have affected the reliability of this three phase feeder line. There can be observed overheating of all three arresters (Fig.5). If this situation would last for too long an fault could occur and the lines held by arresters will be unoperational causing significant costs.

V. SUMMARY

In order to maintain the reliability of a power transmission lines and distribution system, it is important to be able to identify possible future fault locations. Infrared thermal imaging can make it easier and faster.

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Renewable Energy Sources in Context of Global Energy Market

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This paper is going to define mostly common instructions of European Union in correspondence with Directive 2001/77/WE and some legislative steps in achieving certain goals by different countries on the basis of the examples of Polish regulations.

I. KYOTO

Main protocol of every decisions made in European regulations, determining usage of renewable energy sources was delivered by Kyoto arrangement established in 1997 yr in Kyoto, Japan. Main goals of listings made by this paper were to decrease massive growth of carbon dioxide world's emissions.

Second reason for so strict decisions was the problem of world fossil fuels resources running out in period of next 60 yrs. This was caused also by predicted rise of fossil fuels prices on global market. Therefore Conference on the Human Environment decided to sign United Nations Framework Convention on Climate Change called Kyoto protocol or with abbreviation UNFCCC or FCCC. Up till now this convention was signed by 175 parties with EU treated as one, with its own rights. Unfortunately this treaty was not ratified by the biggest countries in terms of global greenhouse gas emissions. For now USA an Kazakhstan didn't signed ratification acts.

Main of the establishes signed by Kyoto Protocol are the following principles[1]:

- *Kyoto is underwritten by governments and is governed by global legislation enacted under the UN's aegis;*
- *Governments are discriminated into two categories: developed countries, referred to as Annex I countries (who have accepted greenhouse gas emission reduction obligations and must submit an annual greenhouse gas inventory) and developing countries, referred to as Non-Annex I countries (who have no greenhouse gas emission reduction obligations but may participate in the Clean Development Mechanism),*
- *Any Annex I country which will fail to met its Kyoto obligation will be penalized by duty of submission 1.3 emission allowances in a second commitment period for every ton of greenhouse gas emissions it exceeded their cap in the first commitment period (i.e., 2008-2012),*
  From January 2008, till 2012, Annex I countries are obligated to reduce their greenhouse gas emissions by a collective average of 5,2 % below their 1990 levels (for many countries, such as the EU member states, this corresponds to some 15%

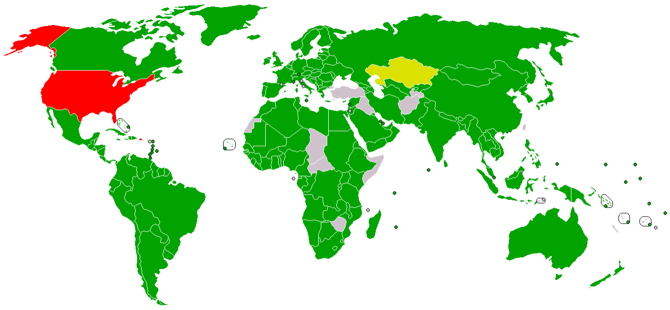

Figure 1. Indication map of Kyoto ratification.

  below their expected greenhouse gas emissions in 2008). While the average emissions reduction is 5%, national limitations range from an 8% average reduction across the European Union to a 10% emissions increase for Iceland; but since the EU member states each have individual obligations, much larger increases (up to 27%) are allowed for some of the less developed EU countries (see below #Increase in greenhouse gas emission since 1990). Reduction limitations expire in 2013;

- *Kyoto includes "flexible mechanisms" which allow Annex I economies to meet their greenhouse gas emission limitation by purchasing GHG emission reductions from elsewhere. These can be bought either from financial exchanges, from projects which reduce emissions in non-Annex I economies under the Clean Development Mechanism (CDM), from other Annex 1 countries under the JI, or from Annex I countries with excess allowances. Only CDM Executive*
- *Board-accredited Certified Emission Reductions (CER) can be bought and sold in this manner. Under the aegis of the UN, Kyoto established this Bonn-based Clean Development Mechanism Executive Board to assess and approve projects ("CDM Projects") in Non-Annex I economies prior to awarding CERs.*

II. EU DIRECTIVES

Concerning this Kyoto treaty EU made its own directive [2] which describes European regulations on renewable energy sources. Main aim of this document is growth in participation of green energy sources in global (i.e. European) internal energy market. Of course this drives to consider delivering some unified legislative base of proceedings for every UE country. And for those it provides individual indicative indicators that should be applied till 2012 yr (e.g. 12,5 % gross of green share in energy market in Poland).

[2] impose duty on countries to define each of every renewable source with special way of treating in sense of help with developing that country provides. It also should describe way of possessing certificates. Then certain commission of European Administration will decide either to register this in unified document or not. [2] also impose duty on National Power Supplier (if it occurs) to provide priority in network access for energy produced by renewable sources.

Other directive 2003/54/WE [3] adds to this general provisions other more attractive for general purpose regulations, which considers developing of free energy market and oblige municipalities to provide amenities for future producers of energy in setting a new plant and other administrative procedures. It also guarantees transparency of the working system.

A. Polish achievements [4]

A big evaluation took place In Polish legislative forms of green promotion. In our country electrical market and whole administration of electro-energetic system lies in hands of The Energy Regulatory Office (pl. Urząd Regulacji Energetyki, URE), which publishes most of regulation considering renewable energy market.

Polish government set up new quality by choosing authorization. It is worth mentioning that it applies to all kinds of operations subject to licensing (the catalogue of possible forms of availability has been developed in order to adjust the Polish solutions to the guidelines of Directive 2003/54/EC). It allows not only to control the entry on the energy market and to define individual terms and conditions of a licensed operator's activity, but also to monitor its proceedings which may determine (in case of law enforcement) possible license withdrawal.

These Polish legal regulations impose an obligation of getting a license for on entrepreneurs who carry out energy activities in the field of generation of electricity in sources of equal or higher than 5 MW of power capacity, transmission and distribution of electricity, trade in electricity excluding trade through consumer-owned installations of voltage below 1 kV, as well as trade at the power exchange. Introduction of this regulation in 2005 caused serious stop in developing of small energy market because of complicated procedure permitting possession of this certification. Therefore procedure of erection of any kind of renewable energy plant (which are in most cases small) is strongly elongated. Due to serious costs of investment private sector in energy producers market is very small (long time of repayment). Also information about prices of repurchase green energy from market by national suppliers is very weak. In most cases it is negotiated individually.

B. How it should look like (in my opinion)

First and most important thing is clearance of legislative forms and acts, which could provide more information and promotion of energy production market. Composure of regulations concerning green energy producers is discordant with European recommendation. Its composure is caused by mistaken conception which devolve country obligations on to shoulders of energy producer in oblige to own certificates on exact amount of this energy.

Of course it is necessary not to treat (as it is) green energy on equal rights with conventional energy sources. Due to high cost of installation green plants cannot be competitive with old working plants; e.g. in Germany difference between price of green energy by selling it to the system is 4 times higher than price of energy which can be bought from system. This gives opportunity to repay the investment in period of 10 years. In Poland it is impossible to calculate.

C. EU energy problems [5]

EU wants the developed countries to reduce the greenhouse gas emission by 30% by 2020, as well as to improve energy efficiency by 20% by 2020 and at last to increase level of bio fuels in transport fuel to 10% by 2020

Main reason of European problems with green energy consumption is lack of this energy. Directives and EU council do not provide any issued by a superior relevant regulations about the future of developing in context of energy market. European Commission didn't work on proper directive which gathers all regulations in one book and is forcing new European countries to ratify one unified legislative form.

This kind of action would also encourage well working private sellers of green energy to get some new markets of new European countries.

III. Energy – where is it

It is necessary to say that main (green) energy sources are not in the wind (because of technical limitations and special characteristic of working) and also not in solar energy. Water and biomass are the main energy sources that can provide level of supply of today's power plant's and are still being environmentally safe and clean.

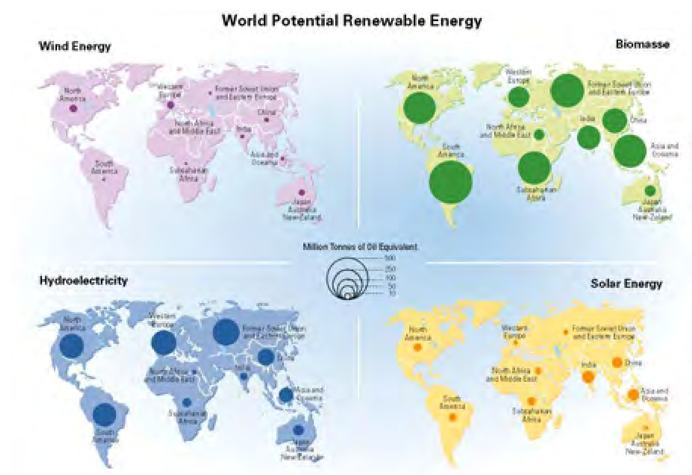

Figure 2. Map of energy (2006)[5]

IV. Summary

Words of summary that should took place here can be different. We can say that for this kind of actions we witness time is a relevant adviser. But on other hand Europe needs clean energy and will need it in larger scale if we are thinking of stopping green house effect and large rise of carbon dioxide emission.

Green energy should be applied in every places where such possibility exists. One of the ways to achieve such occasion is to work on a law which is provided for these purposes in countries with relatively low share of renewable energy sources in market of energy. This work aims to prepare detailed description of issues associated with requirements dedicated to dispersed (mostly green) energy sources investments. Main reason for this work still is a crucial need to clarify and unify complicated legislative problems accompanying embedded generation with additional description of government offices participation. Special attention should be concentrated on technical aspects delivered by conditions for point of common coupling defined by local distributed company (also to unify with EU regulations). Intention of the final effects should be schedule scheme for investors who make a plan for dispersed energy sources.

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Biomass as the Energy Source

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***Abstract* – Overview of the biomass (biofuels) problem around the World**

I. INTRODUCTION

The term bioenergy (biomass) denotes the use of vegetable matter as a source of energy; it covers a variety of fuels, with applications in all the major sectors of consumption – power generation, transportation, industry, households, etc.

Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. The chemical energy in plants gets passed on to animals and people that eat them. Biomass is a renewable energy source because we can always grow more trees and crops, and waste will always exist. Some examples of biomass fuels are wood, crops, manure, and some garbage.

II. TYPES OF BIOMASS

There are many types of plants in the world, and many ways they can be used for energy production. In general there are two approaches: growing plants specifically for energy use, and using the residues from plants that are used for other things. The best approaches vary from region to region according to climate, soils, geography, population, and so on.

III. CONVERTING BIOMASS TO ENERGY

The old way of converting biomass to energy, practiced for thousands of years, is simply to burn it to produce heat. This is still how most biomass is put to use. The heat can be used directly, for heating, cooking, and industrial processes, or indirectly, to produce electricity. The problems with burning biomass are that much of the energy is wasted and that it can cause some pollution if it is not carefully controlled. The simplifed eletrical power generation process is shown on fig. 1.

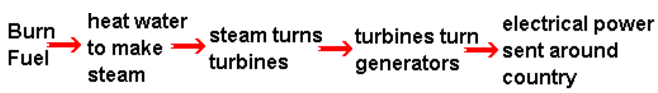

Figure 1. Simple eletrical power generation process.

An approach that may increase the use of biomass energy in the short term is to burn it mixed with coal in power plants—a process known as "co-firing." Biomass feedstock can substitute up to 20 percent of the coal used in a boiler. The benefits associated with biomass co-firing include lower operating costs, reductions of harmful emissions, and greater energy security. Co-firing is also one of the more economically viable ways to increase biomass power generation today.

A number of noncombustion methods are available for converting biomass to energy. These processes convert raw biomass into a variety of gaseous, liquid, or solid fuels that can then be used directly in a power plant for energy generation. The carbohydrates in biomass, which are comprised of oxygen, carbon, and hydrogen, can be broken down into a variety of chemicals, some of which are useful fuels. This conversion can be done in three ways.

A. Thermochemical

When plant matter is heated but not burned, it breaks down into various gases, liquids, and solids. These products can then be further processed and refined into useful fuels such as methane and alcohol. Biomass gasifiers capture methane released from the plants and burn it in a gas turbine to produce electricity. Another approach is to take these fuels and run them through fuel cells, converting the hydrogen-rich fuels into electricity and water, with few or no emissions.

B. Biochemical

Bacteria, yeasts, and enzymes also break down carbohydrates. Fermentation, the process used to make wine, changes biomass liquids into alcohol, a combustible fuel. A similar process is used to turn corn into grain alcohol or ethanol, which is mixed with gasoline to make gasohol. Also, when bacteria break down biomass, methane and carbon dioxide are produced. This methane can be captured, in sewage treatment plants and landfills, for example, and burned for heat and power.

C. Chemical

Biomass oils, like soybean and canola oil, can be chemically converted into a liquid fuel similar to diesel fuel, and into gasoline additives. Cooking oil from restaurants, for example, has been used as a source to make "biodiesel" for trucks. (A better way to produce biodiesel is to use algae as a source of oils.)

IV. BIOMASS AND THE ENVIRONMENT

Biomass can pollute the air when it is burned, though not as much as fossil fuels. Burning biomass fuels does not produce pollutants like sulfur, that can cause acid rain. When burned, biomass does release carbon dioxide, a greenhouse gas. But when biomass crops are grown, a nearly equivalent amount of carbon dioxide is captured through photosynthesis.

Each of the different forms and uses of biomass impact the environment in a different way.

V. Biomass for electricity generation

The largest secondary transformation of biomass after charcoal production is in the electricity sector. For many years biomass processing industries such as sugar, wood products and chemical pulping (black liquor) have installed ombined heat and power, also known as cogeneration, plants. Many of these have been relatively low-steam temperature installations, with only sufficient electricity to meet the plant processing needs.

Since the 1970s there has been a large expansion of biomass-based electricity generation, with an increased emphasis on generating efficiency, resulting in electricity exports into liberalised or deregulated markets. In addition, there has been an expansion of district heating schemes with CHP in Scandinavia, based on straw in Denmark and wood residues in Sweden and Finland. In countries with extensive coal-fired electricity generation there have been incentives under climate schemes to co-fire biomass in order to achieve carbon offsets of up to 15%. Germany and other countries have also stimulated the generation of electricity from urban residue streams in energy from waste (EFW) facilities, from land fill methane, and from anaerobic digestors associated with the animal husbandry sector. India, China and Brazil have also invested in rural electricity generation from producer gas and vegetable oils.

In 2005 estimated total electricity generation was about 180 TWh from an installed capacity in excess of 40 GW at an average 20% efficiency The overall rate of growth has been greater than 5% in the last decade as shown in tab. 1 and in tab. 2 the leading biopower producers are listed.

A key issue for the biopower sector is efficiency. The move towards co-firing with coal has the advantage that the efficiency when firing the blended fuel is that of the original coal boiler with little or no loss relative to the coal component.

TABEL 1

Electricity production from biomass (TWh), 2005

	1995	2002	2003	2004	2005
Solid biomass	85.3	110.0	118.2	131.4	134.9
Biogas	6.0	16.9	18.3	20.7	24.8
Liquid biomass	-	-	0.8	0.6	0.9
Municipal solid waste	13.4	21.3	25.0	24.0	22.8
Total	104.8	148.2	162.2	176.6	183.4

TABEL 2

Leading biopower producing countries, 2005

	Production	Percentage of world
	TWh	%
USA	56.3	30.7
Germany	13.4	7.3
Brazil	13.4	7.3
Japan	9.4	5.1
Finland	8.9	4.9
UK	8.5	4.7
Canada	8.4	4.6
Spain	7.8	4.3
Rest of World	57.1	31.1

V. Summary

Biomass currently provides about 10% of the world's primary energy supplies most being used in developing countries as fuel wood or charcoal for heating and cooking. Biomass use for power and CHP generation is steadily expanding in Europe, mainly in Austria, Germany, the United Kingdom, Denmark, Finland and Sweden, where bioelectricity is mostly produced from wood residues and Municipal solid waste (MGW) in cogeneration plants. Favored by resource abundance and national policies, the European Nordic countries not only produce bio-power but also export equipment and services for biomass power generation. According to Global Status Report 2006, global biomass power capacity added in 2005 amounted to 2–3 GW, bringing total capacity to about 44 GW. In 2004 Germany, Hungary, the Netherlands, Poland, and Spain registered annual capacity increases of 50% – 100% or more. In Australia, Austria, Belgium, Denmark, Italy, South Korea, New Zealand and Sweden, growth was in the range of 10% – 30%. The biomass power industry is also active in the United States where some 85% of total wood process wastes (excluding forest residues) are used for power generation. Countries that are major producers of sugar cane are often major producers of (or are developing) bio-electricity from bagasse power plants. Progress with rural use of biomass energy is difficult to track. It is especially hard to distinguish between modern and traditional biomass use, which still dominates in rural areas of developing countries. China, Brazil, Latin American, Thailand, Cambodia and India are turning increasingly to biomass power plants and gasifiers alongside solar PV, small hydro and wind power. Some 70 MW of small-scale biomass gasification systems for off-grid power generation and 3.8 million household-scale biogas plants are installed in India. China reported 17 million existing biogas users in 2005. Use of biomass stoves is growing in Africa (Morocco, Uganda, Malawi, Ethiopia). Heat and power generation from biomass accounted for 7% of some $38 billion invested in new renewable energy capacity worldwide in 2005 (excluding large hydro). That leads us to the conclusion, that biomass is one of the future energy sources.

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IEEE Conference Publishing

History

The Alma Mater Viadrina was founded in 1506 in Frankfurt(Oder), Brandenburg, and was the first university in the prussian-brandenburg state. It was one of the most important centres of study in that region. At these times many positions of influence were given to lawyers, theologists and medicine professors of the Alma Mater Viadrina. Some of the most important alumnies and professors were the brothers Humboldt, Ulrich von Hutten, Thomas Muenzer and Heinrich von Kleist. Even at these times the Viadrina was a sign for intercultural cooperation and the living together of nations.
The University resembled the most eastern point of progressive teaching with about 1300 students from Lithuania and Poland.
In 1811 the university in Frankfurt(Oder) was closed because of the disagreement about the existence of two university that were that close to each other. The preference was given to the University of Berlin, founded in 1810, which today carries the name of the Humboldt brothers. Only a few employees went to work in Berlin. The majority and the complete inventory went to Breslau, to the Leopoldina. This further show how strong the cooperation of the two neighbouring nations was at that time.
Starting in 1989 the first thoughts about a reopening of the University were taken public and a concept was worked out.
The main idea was to establish a University at a central point that concentrates on the questions of the present and future of Europe.

In 1991 the European University Viadrina was solemnly opened with three faculties, law, cultural science and economics. The focus lays to a great extent on foreign languages and intercultural knowledge.

The goals were stated by the president of the University Gesine Schwan as follows: "Our goal is the promotion of the growing together of Europe." Today about 40% of the students come from 80 foreign nations and all continents, where as the most of them are polish in origion. See figure 1.

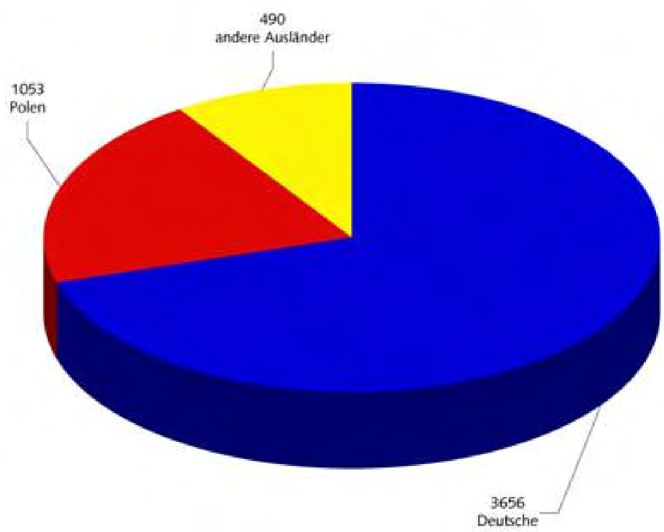
Adam-Mickiewicz University Poznan

The Adam-Mickiewicz University in Poznan represents one of the most important cooperation's out of the 170 international cooperations of the European University Viadrina.

She was founded in 1919 under the name Priest University and had two faculties. Until now 11 more faculties were opened besides the previous faculty of law and philosophy. The University thus became one of the most famous institutions in Poland.

4600 employees and 50.000 students use the establishment where of 900 are matriculated at the Viadrina.

Figure 1



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German-Polish Science Foundation

The foundation was founded in 2006 with the goal to promote the science and intercultural communication between Germany and Poland. The headquarter is located in Frankfurt(Oder).

Innovative projects on both sides are supported and cared for with funding from the German ministry of education, 50 million euro, and 5 million from the Polish side.

Collegium Polonicum

In 1998 the Collegium was founded to create a common scientific establishment, in Słubice, to promote scientific and cultural exchange between the countries. The students thus have further possibilities for German- Polish exchange.

The Collegium focuses its support on right these themes as for example "My Life" where biographies of Germans and Polish are collected and saved. Thus statements about the living together, the work environment and the resettlement, driving away can be analysed.

Another project is the "European Fellows PhD program" which focuses on the politic and economic organisation and the progression and showing of differences and possibilities within Europe.

The last example is the „Dedecius Archiv". Karl Dedecius is known to be a mediator between Germany and Poland. The archived files document the relationship between the two nations in the last 50 years. It consists out of photos, audio recordings, documents, newsletters, and letters which represent the flow of information between the countries.

Activities of the European-University Viadrina

The University supports many projects in the region and across the border. Some of them are show below.

The German-Polish Career centre of the University is organising the job exposition "Viadukt" for example. It is the only one of its kind that offers information about possibilities of studying and working in Germany and Poland. The students find support for job applications and practice semester in foreign countries. Many presentations and workshops illustrate the work environment in Poland.

Once per year the Viadrina price is awarded to important persons for their engagement in progressive understanding about the living together of nations. Former co- founder of the University PhD M.D. Rudolf von Thadden for example was awarded this price for his engagement in German-Polish cooperation in 2005. He was given 2500 Euro for his initiative for the German-polish reconciliation and his critical views on the prussian history concerning Poland.

A further project of the Collegium Polonicum is the "Cross-Border-Fibre" which is a data connection between the two countries. It speeds up the data transfer between students and researchers of both nations. The connection allows over 500 German Universities and research facilities to transfer data to their neighbours directly with the speed of 10 GB per second, without using the internet. This becomes very handy in data extensive fields of study like geophysics and bioinformatics. This further promotes joint research between Poland and Germany and allocates the Viadrina further in the middle of Europe.

The technology and knowledge transfer facility is a joint project of the Viadrina and the Institute for innovative Microelectronics (IHP) which commits itself to the goal to support small and medium businesses with basic scientific knowledge. The assignment of the facility is to locate the demand of businesses in the region for economic, cultural and law knowledge and to develop projects at the Viadrina that respond to that demand. The facility further creates direct contacts between professors and business man. The over all goal is it to represent the European University Viadrina and the IHP as one and promote Frankfurt(Oder) as a centre of high technology with social competence.

The Frankfurt Institute for transformation studies will be the last example. The institute consists of employees and doctors of all three faculties at the Viadrina and investigates the transformation process of post socialist countries. In that they combine all three parts, law, economics and social studies to analyse the economic system of these. The most recent themes are the correlation problems of the new Member states of the European Union and the problems that arise with the EU east extension. The Integration process and the consequence for the German – Polish border region are investigated as well. These themes have to be analysed from all points of view and that assignment brings the European University Viadrina into play.

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Electricity Storage Systems

Rafał Kurnatowski

I. INTRODUCTION

Introduction

Nowadays we see increase of permanent costs, payed by world economy as a reason of bad quality of electric energy. Very active part of prevent solutions takes "The Leonardo da Vinci Program for Power Quality" in Europe. Also in USA similar investigations take place. It's is known that in next 15 years USA will intend 175mld $ for initiation Energy Storage. Main goals of Energy Storage are increase of quality of energy and assure safety and efficiency of energy market.

Conventionally we can split storage systems for two groups:

- Dynamic Energy Storage – for prevent disturbances in electric system which last for a very short time
- System Energy Storage - for making better balance of energy for twenty-four hours

II. STORAGE SYSTEMS

A. *Super-capacitors*

These devices are able to keep and receive a lot of energy with very small time constant.
In comparison to classical capacitors, super-capacitor can accumulate from 10 to 100 times more energy.

Electrodes are often made from porous carbon material. Electrolyte is aqueous or organic.

Example of parameters one of nowadays used super-capacitor are: C=5kF, U=2,7V
Capacitors are connected in series and can give energy about 3,6 MWs

At present we use them in mobile phones, laptops etc.

B. *Battery Storage Systems*

Main advantage of these devices is very big density of stored energy. They are the making of reducing peak on-peak demand, helping with transmission difficulties etc.

Battery energy storage system consists: batteries, power conversion modules, protection and control devices, power transformers.

TABLE I
TYPES OF STORAGE SYSTEMS

DYNAMIC ENERGY STORAGE	SYSTEM ENERGY STORAGE
- super-capacitors - SMES - flywheels - battery storage	- pumped hydro - fuel cells - CAES

TABLE II
CONVENTIONAL BATTERY TECHNOLOGIES

CONVENTIONAL BATTERY TECHNOLOGIES
Lithium – ion Lithium – polymer Nickel- metal hydride Nickel- cadmium Lead – acid Liquid - electrolyte

C. Flywheels

They are used to store a big part of energy and fast receive it. This system consists of a massive rotating cylinder that is supported on a stator.
Some key features: little maintenance, environmentally inert material, long life (sometimes even 20 years)

TABLE III
FLYWHEELS SYSTEMS COMPARISON

Systems	Basis of construction
Low-speed systems	Rim is made from solid steel. Winding rotate in rare air. Rational speed is equal about 6000 round per minute.
High-speed systems	Composite rim. Rotor consists permanent magnet. It rotates in vacuum with rational speed equal about 60 000 round per minute.

Stored energy in these devices is directly related to mechanical rotation.

$$E=(I\omega^2)/2 \tag{1}$$

$$E=(mv^2)/2 \tag{2}$$

E-energy, I- moment of inertia, ω-rotational velocity, m- mass, v- linear velocity

D. SMES – Superconducting Magnetic Energy Storage

The basis of working is to keep energy in inductance coil's magnetic field. The coil is made from superconductor.
Losses in winding are neglected because coil works in a very low temperatures (about 20 K). Conductor is cooled in liquid nitrogen. Overall efficiency in commercial applications is very high.

The magnetic energy stored by a coil

$$E = \frac{1}{2} \cdot L \cdot I^2 \tag{3}$$

E- energy [J]
L- inductance [H]
I - current [A]

E. CAES – Compressed Air Energy Storage

When energy cost is low (at night time), it is used to compress air to about 70 atm. The air is stored in great underground caves. At peak demand time compressed air is used to drive conventional gas turbine.
Uniform pressure is in the range of 8-10bar.That technology is widely used in industry. First commercial CAES was build in Germany in 1978. It was a 290MW unit. The largest construction is planned to be build in Ohio. It will operate with power 2700 MW.

F. Fuel cells

As a result of electrochemical reaction of connection hydrogen and oxygen we obtain here electric power or heat. A water is by-product.
Nowadays fuel cells have to work with batteries. Work temperature of these devices is between 80 ºC to 1000 ºC. The disadvantage is that they need ultra pure fuel.
They have potential to revolute international way of electric power supply. Initiation of fuel cells to everyday usage devices is predicted to year 2015.

G. Pumped Hydro Storage

Conventional pumped hydro consists two water reservoirs. In peak off time water is pumped from the lower reservoir to upper one. At peak demand hours the water flow from upper part to lower and drive generator.
Depending on construction, pumped hydro can discharge from several hours to a few days. Efficiency is in the 75% to 80% range. Nowadays we have 90GW of pumped storage which is 3% of global generation capacity.

III. IMPORTANCE OF ENERGY STORAGE

Energy storage is important because it:

- Can help reduce on-peak demand
- Can help with transmission difficulties
- Can help match supply to demand
- Can raise asset utilization

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The prototype of electrovalve control system

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***Abstract* -This paper shows the possibility of application a simple electrovalve work controller system. It's supposed to enable a better usage of warm water. Encouragement of this paper is based on an internet forum.**

NOMENCLATURE

Q	- heat needed to warm up water, (kJ)
m	- mass, (kg)
c_w	- specific heat, (kJ/kg*K)
ΔT	- temperature difference, (K)
Q_{dost}	- Q with losses of the boiler, (kJ)
τ	- work time of the electric heater, (s)
A	- used electric energy, (kWh)
k_e	- costs of electric energy, (zł/kWh)
k_A	- costs of electric heater work, (zł/day)
$k_{A,S}$	- costs of electric heater work per season, (zł/season)
Q_{br}	- savings without working system costs, (zł/season)
Q_{nt}	- savings with working system costs, (zł/season)

I. INTRODUCTION

The main aim of the system is to maintain the water flow between central heating furnace and boiler. To achieve the correct flow an electrovalve was used in the central heating circulation and a simple water and boiler temperature difference respondent microprocessor controller.

Problem

Heated water is pumped into the boiler's pipe coil and radiators, where it warms up the spaces and the in-boiler water, giving the heat back. Next, the water comes back into the furnace, where it's heated up once again. Burning out coke gives less heat and the in-flow water has lower temperature till the moment when the in-boiler stored water will be used to warm up the rooms, not according to the purpose. The additional electric energy will be needed to achieve usable warm water.

Solution

The solution seems to be very obvious. The temperatures are measured in the boiler as well as in the furnace. When the furnace's water temperature will be higher than the one in boiler's over the fixed time, the relay is enclosed, turning the electrovalve on. The electrovalve opens and the water can easily flow into the pipe coil. The temperatures equalize, the electrovalve is closed and the further flow of water through the pipe coil is prevented. The boiler's water keeps its temperature till the moment, when it will be used and the decrease is filled up from the waterworks. This fact causes the boiler's water temperature to decrease and makes the repetition of the cycle.

II. SYSTEM CONSTRUCTION

The controller is built on 8051-family 8-bit microcontroller AT89C4051 , Atmel Corporation. Two DS18B20 1-wire bus, Dallas-Maxim digital thermometers are used. A simple four-key keyboard and a 2*16 LCD display communicates with the user. The relay is fed-back with the microprocessor by a optical coupler. A power transformer with two secondary winding supplies an electronic part. A +5V voltage is used to supply the microcontroller, thermometers and the LCD display. A +12V voltage is used to control the relay. The electrovalve is mounted on the outflow of the pipe coil. Electrovalve coil requires 230V voltage. The program is written in Bascom. This programming system offers many 1-wire, LCD-display and programmer procedure library in consequence writing programs in Bascom is similar to high-level programming languages.

III. MEASUREMENTS AND CALCULATIONS

The whole working system is described on the ground of measurements, which were made within 30 successive hours of work. The results shows figure 1. The measurements were made too rarely, so the results aren't too precise, but they still give the general idea of temperature changes. The electrovalve was opened under the condition that the furnace's water temperature was higher more than 4 degrees Celsius than the boiler's water temperature and the difference between the two had to remain at least for 30 seconds.

During the measurements the boiler's water temperature was 3 times higher than the one in furnace. Maximum or not, the temperatures were as follows: 0,9; 4,3; 4,5 degrees Celsius. The supply water temperature was oscillating between 10 and

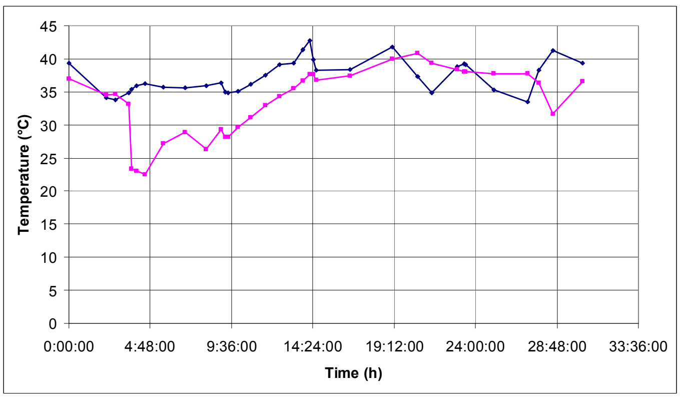

Figure 1.Changes of the temperature in time; red line in-boiler water, blue line in-flow water

13 where the outside temperature was between limits of 0 and 2 degrees Celsius. The maximum temperature difference between furnace's and boiler's water was about 10 degrees Celsius during the whole few-months period of regular work.

The system was not build on savings – it was designed to provide the comfort of exploiting warm water. The savings have to be understood as the cost of heating the water up to a certain level by an electric heater. It is obvious that, if there were no controller steering of electrovalve, the stored heat would be wasted, heating the environment space.

Taking the upper values it is simple to estimate the amount of saved money.

First thing is to count up the heat needed to warm up 80liters of water to a certain temperature. It is assumed that everything is happening in a stationary system.

$$Q = m \cdot c_w \cdot \Delta T = 80 \cdot 4{,}186 \cdot 0{,}9 = 301kJ \tag{1}$$

Taking into account the boiler losses:

$$Q_{dost} = \frac{301}{0{,}95} = 317kJ \tag{2}$$

Electric heater uses 2 kW of electric energy, so to heat up the water to the same temperature, it would had to work for:

$$\tau = \frac{Q_{dost}}{P} = \frac{317}{2} = 159s \tag{3}$$

Electric energy comes to:

$$A = \tau \cdot P = 0{,}0442 \cdot 2 = 0{,}0884kWh \tag{4}$$

It will cost, assuming that electric energy costs 0,40 zł/kWh:

$$k_A = A \cdot k_e = 0{,}0884 \cdot 0{,}40 = 0{,}04 zł / day \tag{5}$$

Table 1 shows a results of calculations for the other temperature differences.

To estimate, how high savings we can achieve it's needed to establish that:

-warm water will be used every morning; it's temperature must be higher of 10 degrees Celsius than the central heating water,

TABLE I
TABLE OF COSTS

ΔT	Q	Q_{dost}	τ	τ	τ	A	k_A
K	kJ	kJ	s	min	h	kWh	zł
0,9	301	317	159	2,65	0,0442	0,0884	0,04
4,3	1440	1516	758	12,63	0,2105	0,4210	0,17
4,5	1507	1586	793	13,22	0,2203	0,4406	0,18
5,0	1674	1763	881	14,69	0,2447	0,4894	0,20
10,0	3349	3525	1763	29,38	0,4897	0,9794	0,39

-if the water won't have the appropriate temperature, it will be heated up by an electric heater,

-the system works from 1st October till 30-th March

Due to the fact that it was impossible to estimate how many times during the whole cycle of work we achieved 10, 7 and 5 degrees Celsius temperature difference, it is worth to accept concrete values. We chose:

-during 100 days we achieve 5 degrees Celsius difference

-during 83 days we achieve 10 degrees Celsius difference.

Taking into account upper approximations we can start to count our savings:

$$O_{br} = 100 \cdot 0{,}20 + 83 \cdot 0{,}39 = 52{,}37 zł / season \tag{6}$$

The next step is to count the work cost of the whole system. The active power used by the electrovalve is 8 W, the electronic part of the system uses maximum 1,8W. Analyzing the figure 1 we can obtain that the electrovalve was working for about 12 hours per day.

$$A = 24 \cdot 1{,}8 + 12 \cdot 8 = 0{,}1392kWh \tag{7}$$

$$k_A = 0{,}1392 \cdot 0{,}40 = 0{,}06 zł / day \tag{8}$$

$$k_{A,S} = k_A \cdot 183 = 0{,}06 \cdot 183 = 10{,}98 zł / season \tag{9}$$

$$O_{nt} = O_{br} - k_{A,S} = 52{,}37 - 10{,}98 = 41{,}39 zł / season \tag{10}$$

IV. Comments and Conclusions

These are savings achieved during one season. The cost of materials needed to build the system is close to 280 zł without the job taken up. The system was build to increase the comfort of exploiting warm water, additionally it allows the user to save money. This system pays off after 7 seasons.

A good concept is a measuring device which will measure the temperatures and store results in an EEPROM memory or in a hard drive. It can give a better idea of temperature changes.

Actually a new prototype of a controller with two relays is being introduced. It includes a real-time clock and an EEPROM memory. This bring new possibilities to life. It can control either electrovalve with a pump or an electrovalve with an electric heater.

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Wind Power Generation-Related Power Quality Issues

LU Yan

***Abstract*—As a promising renewable alternative, the wind power is highly expected to contribute a significant part of generation in power systems in the future, but this also bring new integration related power quality issues, which mainly consist of power flow fluctuation analyzed with current, voltage fluctuation and flicker severity factor (P_{lt} and P_{st}) as '*case study*', by its comparatively new characteristics, due to the fluctuation nature of the wind (velocity) and the comparatively new type of its generators (currently popular type of squirrel-cage induction). One practical solution to mitigate the wind generation integration related power quality issues is introduced in this paper, by using Energy Storage System (ESS).**

***Index Terms*—wind power, wind turbine generator (WTG), power quality, power fluctuation, energy storage system (ESS)**

I. INTRODUCTION

The consumption of electricity keeps growing on a worldwide basis, while most countries have set targets to reduce the emission of carbon dioxide or other air, water or soil pollution, which are caused by conventional fossil-fuel's combustion, in order to stop the Earth from warming up further. The widely accepted opinion is that these targets can only be met on one hand by energy-saving incentives and on the other hand by the large scale application of renewable energy [1].

The wind power generation is increasing considered as promising alternative from the aspect of the potential economy in the area with appropriate wind speed other than renewable energy' essential advantages [5]. Whereas, because of the wind power generation has its own characteristics which are different from the existing generating unit such as the fluctuation nature of the wind and the comparatively new types of its generators, connection of wind generators to power system could lead to many disturbances, such as: voltage fluctuations, flickers, harmonics, instability, blind power regulation problems, and transients [3]. These challenges regarding the network integration of wind power mainly consists of keeping an acceptable voltage level, and the power balance of the system, which should comply with fundamental standard reference [6]. Power quality issues connected with wind generation are not only important because of technical aspects, they are also vital on the free energy market.

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To study these integration issues of wind power, this paper starts from general introduction to wind power to analyze wind velocity's influence to wind power. Meanwhile, currently popular generator, which has a squirrel-cage induction machine, is discussed concerned of its impact on power quality indices. In succession, brief presentation of power quality will be covered, and quality parameters' characteristics of supply voltage with wind farms will be concluded from reference [7].

According to the study of reference [5], we will learn a practical solution to mitigate negative impacts of wind power related power quality issues especially with high various penetration levels.

II. WIND POWER AND ITS GENERATOR

Mass in air flowing carries a certain amount of energy, which varies in proportion to the product of the air mass and the square of the velocity [1], as equation (1).

$$P = C_p * 1/2 * \rho * A * V^3 \tag{1}$$

Where:

P: power (Nm/s or Watt)

C_p: mechanical power coefficient (at slow shaft)

ρ : density of air (kg/m3)

A: rotor surface area (m2)

V: wind velocity (m/s)

Not all the energy present in the wind can be converted into usable energy at the rotor shaft. Using physical calculations it can be proven that the theoretical maximum efficiency of wind power is limited at about 59. So, the net electrical power output of a turbine can be determined when mechanical and electrical performance rates are also taken into account, as equation (2):

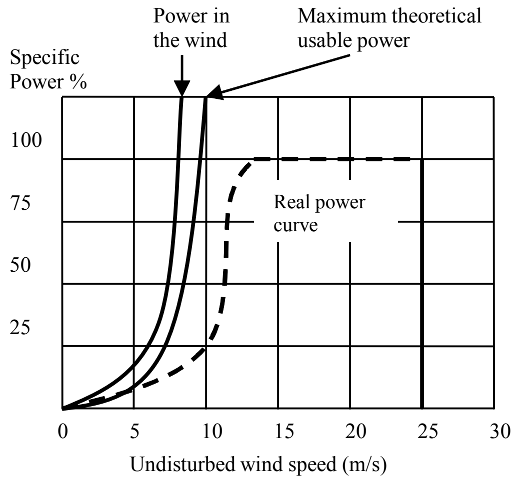
$$P_{elec} = C_e * 1/2 * \rho * A * V^3 \tag{2}$$

Where:

C_e: electrical efficiency rate (%)

Today, large modern turbines are able to achieve a total net efficiency Ce of 42 to 46% with respect to the energy of the undisturbed wind in a circular tube with a cross-sectional area equal to the gross rotor area.

Towards equation (2), we can find wind velocity's apparent influence to wind power, i.e. a disadvantage of wind power is the unpredictability of wind. Storm fronts in particular can cause a sudden increase in the wind power; furthermore, periods of low wind give little wind power.



From Fig. 1, we can conclude that most wind turbines reach maximum power, also called the rated or nominal power, at wind speeds between 12 and 14 m/s [1]. At higher wind speeds, the power has to be kept constant in order not to overload the wind turbine structure or the electrical connection. For instance, at wind speeds over 25 m/s in Fig. 1, wind turbines were designed to shut down in a controlled way.

Another wind power generation's characteristic is its comparatively new types of generators. Reference [3] outlines three main wind generators structures:

1. The simplest and previously popular is the squirrel-cage induction generator connected directly to the grid, which has a fixed pitch of turbine blades generally.
2. Second is the doubly-fed induction generator. The stator winding of this generator is coupled with the system grid, and the rotor winding is connected to a voltage-source converter. This generator operates in wide spectrum of wind speeds and has lower impact on the grid, but the investment costs are higher.
3. Third structure has a synchronous machine, which can be operated in wide wind change range, and active and reactive power and voltage can be controlled. Moreover, this type requires a back-to-back converter for the grid connection to realize a double feed induction.

The first type of above generators cannot perform voltage control and absorbs reactive power from the grid. Phase compensating capacitors are usually directly connected [1] [3]. Although it is cheap and robust and therefore popular, the squirrel-cage induction generator has some defects from the system analysis point of view.

An important disadvantage is that during the switching of the phase compensating capacitors, transients occur, which can induce damages to sensitive apparatus, protection relays and insulation [2] [3] [6]. Furthermore, the impact on power quality indices cannot be ignored. Transient overvoltages and high current will exceed limitations to cause supplying interruption.

III. Power Quality

A. Introduction to power quality

What do we mean by 'power quality'? A perfect power supply would be one that is always available, always within voltage and frequency tolerances, and has a pure noise-free sinusoidal wave shape. Just how much deviation from perfection can be tolerated depends on the user's application, the type of equipment installed and his view of his requirements [2].

Table. I assembles power quality defects, which are the deviations from perfection, fall into five categories and their main possible causes.

From Table I, we can realize the real question concerned of power quality is compatibility between the equipment and the supply [2] [6]. Consequently, ensuring good power quality requires good initial design, effective correction equipment, co-operation with the supplier, frequent monitoring and good maintenance. In other words, it requires a holistic approach and a good understanding of the principles and practice of power quality improvement.

Especially, for wind turbine generator systems, there are some international standard available that characterizing the power quality of a grid connected wind turbine, as reference [6]. Similarly, reference [7] can be taken account of to measuring voltage fluctuation's limitation concerned of wind power generation.

B. Case study

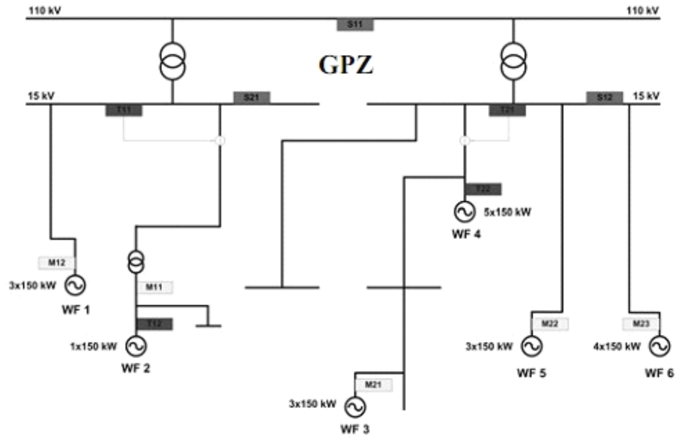
Reference [4] presents the practical measuring results of parameters characterizing power quality for a medium voltage network to which over ten wind turbines were connected, in particular voltage fluctuations in the distribution network are in operation.

The scheme of the analyzed network is shown in Fig.2, whose power quality parameters were recorded in two different periods, and its main purposes are following: power quality measurements at connection points of wind turbines and at a feed point (GPZ), and the quality assessment of existing supply conditions from a standpoint of quality requirements

TABLE I

Power quality defects and their main possible cause

Type	Power quality defects	Main possible cause
1	Harmonic distortion	Arising within the customer's own installation and may or may not propagate onto the network
2	Blackouts	Caused by the supplier but can also by the failure of on-site equipment, conductors and connections
3	Under or over voltage	Caused by fluctuation of the supply voltage, typically due to the use of large fluctuating loads (flicker)
4	Dips (or sags) and surges	The responsibility of the supplier due to harmonic current
5	Transients	Switching or lightning strikes on the network and switching of reactive loads on the consumer's site or on the same circuit



The effect of considered wind farms was calculated using the procedure described in reference [6].

According to the assessment of power quality, several important and effective statements were pointed out during the measurements, which are listed below:

1. From comparison with minimum and maximum values' changes of phase voltages, and maximum of phase currents of wind turbines, it is easily noticed that voltage dips and swells recorded at different measuring positions occur at the same time. However, disturbance, which resulted in the noticed voltage dips and swells, occurred outside the analyzed area of network.
2. From analysis of maximum values of current in relation to minimum and maximum values of voltages, and Long Term Flicker Severity Factor (P_{lt}) for wind farm, it is easily noticed that large values of factors characterizing voltage fluctuations are caused by voltage changes and are not correlated with current changes.
3. From analysis of correlation of phase current and short term flicker severity factor (P_{st}), measured results confirm that wind farms have no effect on a voltage fluctuation level in the analyzed network.
4. From the measured result concerned of the phase current of a wind power plant and P_{lt}, which shows that periods of small values of the P_{lt} at a large current and periods of large values of the P_{lt} at a small current, it was decided, in accordance with reference [6], to exclude the measured values of voltage fluctuation indices recorded during voltage dips/swells.
5. From analysis of numbers of eliminated values of P_{lt}, it was concluded that the events identified at various measuring positions were not connected with a limited area but with the whole analyzed network.
6. From comparison the value of P_{lt} measured with the one calculated with reference [6], noticed difference was appeared. Therefore, in calculation it must be taken into account that resulting values are only an additional component of disturbances and should be added to the existing disturbance level in the analyzed network.

Where:
GPZ: the feed point between wind turbine and supply grid
WF1~6: windmills
Analyzing instruments: TOPAS 1000 (symbol Tx in Fig. 1), MEMOBOX (symbol Mx in Fig.1), and SIEMENS OSCILOSTORE (symbol Sx in Fig. 1)

IV. Mittigation of the Wind Generation Related Power Quality

In fact, the most important hitch of Wind Turbine Generator (WTG) comparing with the fossil-fuel generating units is the irregular stream of electricity caused by the unpredictable wind variations. Especially when the wind power supplies a significant part of the load in the power systems, its intermittence can affect various aspects of power systems, and bring integration related power quality issues.

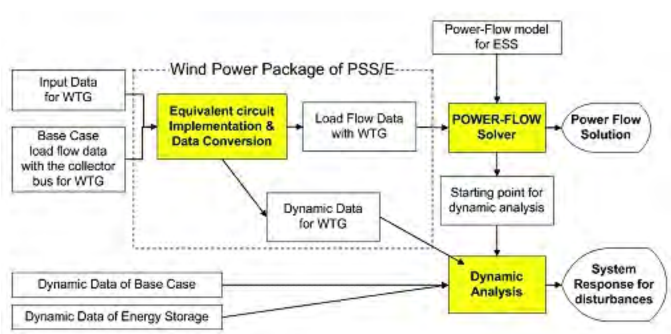
To study these integrations, reference [5] introduces a possible solution for mitigation by the application of Energy Storage System (ESS). The ESS with fast output power control is expected to suppress the wind power fluctuation, improve the power system stability, and counteract to the disturbance on the grid, which is analyzed using one of the most widely used program for the power system analysis, Power System Simulator for Engineering (PSS/E). See Fig. 3.

So, how does ESS realize the suppressive function to wind power fluctuation? The ESS can be controlled to compensate the active power when the active power output of the WTG drops below a specified value, so that the total active power injected into power systems by the wind farm is kept constant regardless of the wind variations.

Comparative simulation results, with and without ESS installation, were analyzed that the active power can be kept constant apparently by compensation of the ESS.

Configuration comparison of ESS connections is applied between distributed and concentrated type. From simulation results, it was easily to see that some capacity of distributed ESS might be wasted under a specific condition because the wind variations at each WTG might be different even in the same wind farm. Inversely, all capacity of the concentrated (aggregated) configuration of ESS could be used for suppressing the power flow fluctuations.

Furthermore, to power system stability problems, the ESS can be a good solution by instantly releasing or absorbing power when the wind power output is suddenly changed.



V. CONCLUSION

The wind power generation, which has been expected to be a promising alternative energy source, should be assessed to guarantee error free operation and good power quality indices, when it is connected to the power grid.

Because of the fluctuation nature of the wind (velocity) and comparatively new and different types of generators, power quality issues should be considered to accomplish 'perfection'. Case study is performed to master calculation procedure as described in IEC 61400-21 (Part 21), and effective conclusions suitable for calculation.

For mitigation of the wind generation related power quality issues, concentrated configuration of ESS seems to be one practical solution, which is not only to suppress the power fluctuation, but also improve power system stability and counteract disturbances.

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VII. BIOGRAPHIES

LU Yan was born in 1984 in China. He received his B.Sc. degree in University of Electronics Science and Technology of China, Chengdu, in 2007. Currently he is proceeding his M.Sc. of Control in Electric Power Engineering in Wroclaw University of Technology, Poland. His interests are power quality and fuzzy logic control.

The usage of geothermal water sources

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SNS „ENERGETYK"

This article presents briefly geothermal water sources of the Earth, Europe and Poland. We focused on its usage for heating purpose. We also analysed the possibilities of exploring the sources, taking into consideration the present condition of water wells and technical possibilities of exploring the wells using the existent thermal network. The model of geothermal power station is also presented below.

I. GENERAL CHARACTERISTIC

Geothermal energy is Earth's thermal energy which is accumulated in grounds, rocks and liquids filling the rocky slots. Resources of this kind of energy are practically inexhaustible. Geothermal energy consists of: energy emerging in the Earth's core (temperatures over 4000°C) and energy resulting in exothermic reactions, and energy of thermonuclear element reactions which is also used in nuclear power stations. Geothermal waters and geothermic steam are extracted in different parts of the world, on different scale and for various purpose.

In our country the percentage of geothermal waters used mainly for heating purpose and to obtain hot water is minimal; and there is no usage of geothermic steam and so called water thrusts.

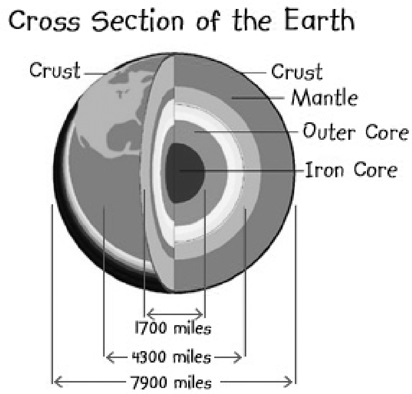
It's important to mention the parameters defining geothermal waters filling the grounds to 3-3,5 km deep; above 3,5 km we have geothermic rocks in the form of magma, so the most important parameters are: temperatures, pressures, level of these water's mineralization. These parameters determine the way of exploitation. For the so called "self-floating" waters, properly high pressure is crucial. And if the pressure is too low, we use pumps. If the temperature is too low, we can make use of around-turbine converter in thermal power plant, heating the geothermal waters to proper temperature. The level of water mineralization also determines the way of exploring them. If it exceeds the admissible level of mineralization (20g/litre), a demineralization station is used on the ground, or water-water exchange, supply water heated in this way to a proper temperature and used later in regular ways in thermal networks. Of course, the worse the parameters are, the higher the solid (investment) cost.

II. BRIEF CHARACTERISTIC OF GEOTHERMAL WATERS AND GEOTHERMIC ROCKS AND HISTORY OF EXPLOITATION IN BRIEF

In the present condition of technical development we are only using the resources which we are capable of exploit. They are: waters (in Poland) and steam. Geothermal sources emerge in favorable conditions. These waters fill the slots in rocks, which are situated in the depth enabling easy exploitation, therefore they are economically profitable. The well is the way of exploiting them. The current depth of these wells is 3-4 km. There are geothermal waters and geothermic steams sources. Geothermic steams sources are found on the grounds of volcanic activity. Temperatures 1 km deep are over 150-200. Geothermal water sources are much more widely spread than the steam sources. Temperature of the water sources 1 km deep is below 150°C.

The deeper we go into the ground, the higher the water temperatures are. The temperature rises about 30°C with every kilometer deeper into the ground. In the depths of the earth there is magma which is hot melted mass of silicates and aluminosilicates. It is this magma that is the direct energy source which heats water to the temperature which makes it turn into steam. And, as heat always goes from warmer to cooler zones, liquid magma, lighter and hotter than the surrounding rocks, sometimes appears on the ground as volcanic lava. But what we can witness more often is the water heated by magma emerging from the earth's depths, in the form of hot springs and geysers.

Figure 1. Cross Section of the Earth



Depending on the temperature, we have the following kinds of geothermal wells:

- shallow (low-temperature, using thermal pumps)
- deep (high-temperature)

TABLE 1.

Layer	Depth (km)	Temperature (°C)
Crust and lithosphere	0-100	930
Mantle	100-2886	2730
Outer core	2886-5156	4200
Inner core	5156-6371	4500

The first try of using geothermal energy to produce electric power took place in Lardello, Italy in 1913. The steam extracted from the ground started turbines up, and therefore producing the power. The power station's power was 250 MW at that time. Now, the station is still working, with its power increased to 420 MW. In North California (The Geyser Valley), Iceland, Japan and many other places hot steam is used in a similar way. Iceland resources transformed into electric power will be sold to Faeroe Islands and to Southern Scotland.
The first natural flows of warm geothermal waters in Poland was found in Sudety Mountains. The legend has it that the Prince Bolesław Wysoki was once hunting in the woods of Jelenia Góra, near Cieplice. He was chasing a wounded deer and he found hot springs in the depths of the forest. It was in 1175. He ordered to build a hunting hut next to the springs and that was supposed to be the beginning of Cieplice town.
In 1381 the Schaffgotsch family became the owner of the health resort Cieplice. The prime of the resort was in 19th century when the new Cieplice was opened to the public and some new methods of treatment were introduced.

III. USAGE OF GEOTHERMAL WATERS

To produce electric power we use water in the form of steam with extremely high temperature – over 150°C. Waters with lower temperature are used mainly for heating or cooling rooms, greenhouses or in bathing facilities. Springs with temperatures over 150°C are found only in some parts of the globe, for example in middle Asia, Eastern and Western Africa and in Europe- in the Alp's mountain range. In some parts of the Earth, especially in Iceland, where the grounds are seismically active, hot springs are found on relatively low depths, or they appear in the form of geysers. These waters are exploited very intensively there. Geothermal energy in Iceland covers 46% of the total electric power demand and 85% of the thermal demand.
Although Poland isn't situated in volcanic grounds, it also has some rich resources of geothermal energy. Over 80% of our country is covered with geostructural pools with geothermal waters. The richest underground water sources are found in the Szczecin-Łódź pool and in Grudziądz-Warsaw pool. In the Tatra Highlands pool the salinity of water is low, temperature is 35-129°C and the outlet pressure is high. However, there are technical and geological problems with the waters exploitation.
Geothermal water sources are divided into:

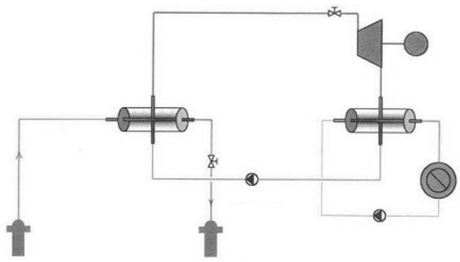
a) dependant on the temperature:
- cold (up to 20°C)
- warm/low-temperature (20-35°C)
- hot/middle-temperature (35-80°C)
- extremely hot/high temperature (80-100°C)
- overheated (over 100°C)

b) dependant on the pressures, shape of the tank and morphology of the ground:
- artesian, where water automatically flows to the surface or up above the ground
- sub-artesian, where rises to high levels but doesn't reach the surface of the ground
- gravitational, where water can only be pumped up

IV. GEOTHERMAL POWER STATION

Power stations or thermal power stations use classic water-steam turbines and organic substance in circulation as well. The substance, known as ORC (Organic Rankine Cycle) use in circulation not steam-water method, but light hydrocarbons. Their steaming energy is only 17% of that of water steaming energy, and that's where you find the economical profitability of ORC power and thermal power stations.

Figure 2. The scheme of ORC geothermal power station.



The scheme of ORC geothermal power station.
There are 2 power circulations: first – geothermal water goes to pipe energy converter and then, it is cooled with the jet pump. Next, it goes back through the second well to the geothermal source.
Meanwhile, in the second circulation, organic energy carrier, which is light hydrocarbon, operates. This kind of power station is called Organic Rankine Cycle (ORC) because of the circulation of the organic substance. Temperature and the amount of the geothermal water determine the boundary conditions while planning the process for a particular power or thermal power station. While adjusting process, experiences of traditional steam-water cycle power stations are used. It enables rational design of devices and flow regulation systems as well.

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DIALUX – program for lighting designers

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DIALux is program supporting building lighting installation in every kind of structure. In this article I will present hoe we can plan this kind of installation and features of this tool.

I. WHAT IS THIS?

A. About program

DIALux - a light-planning program for calculation and visualization of indoor and outdoor lighting systems. DIALux can import from and export to all CAD and has photo realistic visualization with an integrated ray tracer. More than 66 free electronic catalogues and photometric files can be read in. It is available in 25 languages. DIALux is undergoing continuous refinement. The latest standards are always taken into consideration as well as planning regulations and customs of the specific country. DIALux can calculate daylight, interior and exterior lighting, road lighting and emergency lighting. It includes an easy to handle DIALux Light for simple projects and the possibility to create movies directly from the lighting design.

B. System request

System requirements
Processor: P III or later
Frequency: 800 MHz or faster
Main memory: 256 MB RAM
Graphic card: OpenGL able graphic card
Resolution: 1280x1024px

Supported operating systems
Windows Vista
Windows 2000 (with SP4)
Windows XP Home Edition
Windows XP Professional

II. USER INTERFACE

DIALux has adopted the user interface of Windows XP. Dynamic settings of the toolbar, the new and much more comprehensive Guide, simpler dialogues to guide the user all makes working much easier and much faster. The DIALux user interface is divided into three main work areas.

• CAD window
• Project manager with Inspector
• The Guide

These three work areas enable effective and clearly arranged planning of lighting installation with DIALux. In each of these areas you can access certain software functions or edit objects. The Project manager includes the Inspector and the respective tree structure (project, furniture, color, luminaries, and output).

The Project manager enables a fast workflow with the elements used in your lighting design. Each individual element can be selected and its properties can be viewed and modified in the Inspector. The Project manager includes the Inspector and the respective tree structure. With the Inspector you can view the properties of each object selected either in the CAD view or in the Project manager. Here you can also change the properties. Some values have a gray background. These cannot be modified here.

The CAD window is used for the interactive lighting design. We can create there our room, we choose color of walls, and we can add furniture to this room. We work in 3D and 2D environment. Furniture can be moved from the furniture tree to the project (any view) via the mouse using drag and drop. Tree is dividing to seven different categories. From furniture to plants. Also you can create new folder and you can delete existing ones. We also have color tree. It is quite important because different colors have various ratios of reflection.

The Guide accesses all work steps required for the planning. It provides a “connecting thread” and helps you achieve your aims quickly. There we can change many propeteries in seven bookmarks. From example we can insert new furniture we can make light scene. The guide has also another useful tool. It is complemented by the extensive support of daylight calculations. Now daylight scenes can be inserted in your project allowing the influence of daylight in the interior and exterior scenes to be simply calculated. The different sky models (clear, vercast, partially overcast), as well as the direct sunlight influences the calculation. Time and alignment, as well as the daylight obstruction are taken into consideration with the calculation.

Another option in guide is energy performance. The reason why we should pay our attention to this aspect is fact that under the Kyoto protocol, Europe is committed to reduce CO2 emissions seriously. One instrument to achieve this is the directive 2002/91/EC „Energy Performance of Buildings Directive” of the European Parliament and Council. The directive’s requirements hold for both new and to be renovated buildings and for both residential and non-residential buildings. As a guideline the EU created a general framework for the calculation of energy performances of buildings, which stated which aspects the calculation methodology must include at least. These aspects particularly are heating, ventilation, air-conditioning, hot water supply and lighting. To support the implementation of the directive in the EU member states, the European committee for standardization CEN created a set of CEN standards. The part concerning lighting is EN 15193: „Energy performance of buildings – Energy requirements for lighting“. This standard uses an integral approach for the calculation of the energy balance. That is a joint evaluation of energy demands for all parts of the building (heating, ventilation, air conditioning, cooling, humidification, domestic hot water and lighting), taking into account interactions between them and impacts on others. In medium terms, the energy performance for buildings directive causes increased efforts for light planners. Besides the well-known lighting data characteristics, they will also have to pay attention to new energy performance characteristics.

Fortunately, a common light planning already contains a great deal of the needed information for an energy evaluation. This information’s can be analyzed and recycled for the energy evaluation. So if the energy evaluation is integrated into the light planning process as efficient as possible, the additional expenses for this evaluation can be reduced significantly. That’s why DIALux 4.4 offers the possibility to include an energy evaluation according to EN 15193 or DIN 18599.

III. MAKING A PROJECT

If we create a project first time we can choose from one of three creators : DIALux Light, Quick planning or Professional quick planning. Then all work we have to do is following after the creator. First we must write the dimension of room or building. We choose type of material, which are the walls, made from. Now is the main part of making a project. We must select room the data base what type of lamps we use in our plans. The catalogue of products we can download from the Internet. If we register our DIALux we have access to products from big amount of producers from example ES-System, Philips and many more. We have all parameters we need for example power, type of light, type of installation. So we take

Type of work	E_M [lx]	UGR_L	R_a
Rough and average mechanical processing; the tolerance of the processing≥0,1 mm	300	22	60
Precise mechanical processing, polishing; the tolerance of the processing< 0,1 mm	500	19	60
Production of tools, the article the equipment to cuts off	750	19	90
Preparation of the surface, painting	750	25	80
Position of projecting helped by computer	500	19	80
Halls of sessions	500	19	80

chosen

Figure. 1 The requirement of luminaries

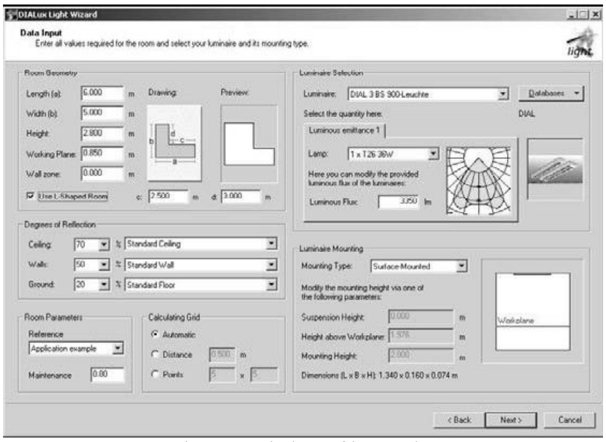

Figure 2 Window of inputs dates

light frame and at least we decide the number of luminaries we need. It depends of type of work which is doing in this building. We can qualify numbers of luminaries we take from European standard PN-EN 12464-1.

Computer does rest job. But we have to remember that the luminaries, who are outside the room, are not considered by DIALux Light in the calculation. In the end we have several choices, you can print the results or save them in electronic format as a pdf file. By using the check boxes next to the printout symbols you can affect which outputs are actually printed out. By default all outputs are activated. If we would like to provide for example only a short overview, activate only The summary. If you would like to present the results to your customer, we may wish to activate all outputs.

IV. WORKING IN 3D

After we calculate our project, client may want to see how it will look like in real. DIALux have a tool whose allowed working in 3D view. It is possible to roam through a planned scene to closely evaluate the results. The observer's position

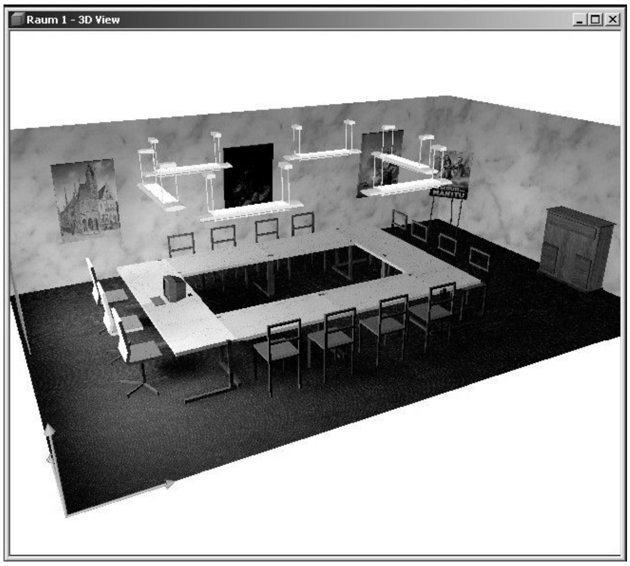

Figure. 3 3D view

can also be inside a room. This is especially valuable when planning large rooms with a lot of furniture. We can change the angel and position of view. We can change the interior of our room we can add furniture and textures. To insert room elements into a room, first of all you have to open the Furniture tree. Then select the file Room Elements. All room elements are displayed in the center of the window. You can insert these simply by Drag & Drop into the 3D view or the ground plan view. You can insert furniture into the project in the same way as room elements by using Drag & Drop or the Property Page. Even we can't find furniture we want we can create your own furniture by combining standard bodies. The following example of a small shelf describes the procedure. With the help of the Luxmeter function you can see the calculated luminance value of any selected point. The calculation results are displayed at the bottom of the figure.

V. VISUALIZATION

Project we can presented as a film. It is big advantage of our program. To create a video with DIALux we have to define the camera path. The camera is not following strictly the path. The path is converged to the edges. That makes the video smoother and there is no judder effect. Besides the camera path and the camera viewing direction, also the video size the number of frames per second and the duration can be defined. The size defines the number of pixels in the X and Y direction on the screen. The higher the resolution, the more space is required to save the video. If we want to prepare a presentation for a TV (DVD or S-VCD) you should select a standard resolution. In the drop down list all the codes installed on the computer will be listed. DIALux does not install these codes. The quality of the code is responsible for the quality of the video. The better a codec is, the smaller the size of the file will be and the higher the quality of the video will be. Some of the codecs are free of charge. The codec has to be installed on the computer that creates the movie and on the computer that plays the movie. Microsoft XP already includes several codecs. These are available on all the XP machines if they were not deselected during the installation of the operating system. Some codes are available from the internet.

VI. SUMMING UP

At the end we see that DIALux is good tool supporting planning and designing lighting installation. DIALux have photo realistic visualization, which helps us to see how the light will be look like. It is available in all the main languages of the world. It cooperates witch CAD programs. We can create films for the presentation of visualization DIALux is continually refined at DIAL by a 15-man development and support team. DIALux always takes the latest norms and standards and the customs of the respective countries into account. Interface is modeled on standard programmers (Windows XP/Vista) and therefore its use is simple and intuitive.

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Frankfurt (Oder)
A Frontier Town with the Change of Time

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I. STRONGER THAN BEFORE

Frankfurt (Oder) is one of the oldest and most interesting frontier towns at the German – Polish border.
Like the river Oder, the town has seen many up and downs during the history. It was destroyed and attacked many times but at last it get stronger than before.
Only economical problems in younger times stopped the growing of the city.

II. FROM TRADER'S SETTLEMENT UP TO HANSEATIC LEAGUE

During the first millennium the city-territory were meagrely settled. The first real settlement at Frankfurt's territory were founded by traders in 1226 and named Nicholas-Settlement because of the "Nikolaikirche". You can trace the name to the Saint Nicholas who is the patron saint of the fishermen, boatmen but first of all of the traders.
Twenty-seven years later in the year 1253 the charter of the foundation of the city Vrankenvorde was signed by Margrave Johann I. Out of the common the charter was written two-times which was not quite unusual but in this case the second document included not only additions like other charters at that time. The text was nearly the same like the first one´s but included additions like the staple and more territory right-hand of the Oder, too.
On account of these rights Frankfurt became an important trading town and from 1430 up till 1525 a member of the Hanseatic League.
Based on its importance, the city became a university town in April 1506. In first academic year 950 academics studied at the Alma Mater Viadrina more than at any other university at that time.

Students of the Viadrina, 1805 (ill.1)

III. DESTRUCTIONS AND CALAMITIES

Frankfurt was destroyed several times during the centuries. The first reversal point in the economical history of Frankfurt was during the Thirty Years' War. In the year 1627 the Elector of Brandenburg and the Emperor of the Holy Roman Empire of the German Nation formed an alliance. Four years later Frankfurt was attacked by the army of King Gustav Adolf. The main offence started on April 3rd 1631 when all imperial troops fled across the Oder. After taking the city the Swedish troops looted and burnt the town nearly to the ground. A few weeks later the plague broke out and 4000 people died.
The population of Frankfurt decreased during the Thirty Years' War. Before the war, the population was about 12000 people. Only 2366 people were still alive five years after the Treaty of Westphalia.
Frankfurt received another setback in February 1811. After the opening of the University of Berlin by Wilhelm von Humboldt it was decided that the Viadrina would be shifted to Breslau. From this time Frankfurt was no more a university town till 1992 when the Viadrina was reinstalled.

IV. 20TH CENTURY TILL TODAY

The city became military base in the 19th and 20th century.
The military importance was especially growing after the First World War because of the strategic location. Frankfurt was a so called "Gauhauptstadt" during the Second World War. In the ending of the war 1945 it was declared as a fortress and evacuated. Three days after the city was taken it was nearly burned down.
Based on the Potsdam Agreement Frankfurt was divided in two parts the German (Frankfurt) and the Polish (Słubice) and became a frontier town. In 1946 when the first Soviet prisoners of war came home they were first send to Gronenfelde in Frankfurt which was the homecomer-camp for all Soviet prisoners of war.
In the GDR Frankfurt became not only importance because of the location as a frontier town but also of the semiconductor industry which was mainly located in Frankfurt. After the German reunification 1990 Frankfurt lost most of its industry even the semiconductor industry which employed 3000 people crashed down. A ray of hope was the reinstallation of the Viadrina 1992. Until today the town has to fight against unemployment but the biggest unnecessary fear is that the crime will may rise since of the ending of the border controls at

December 21, 2007.

V. Famous and Important

During the centuries many historical celebrities were born, lived or studied in Frankfurt (Oder).
The most important person was the poet Heinrich von Kleist who is so called the son of the city. He was born in Frankfurt 1777 and studied at the Viadrina Philosophy, Physics, Mathematics and political science. To honour him Frankfurt holds up yearly the “Kleistfesttage” which contains literary readings, movies and other arrangements around special topics. But also Carl Philipp Bach the famous organist lived and worked in Frankfurt. The concert hall was named after him 1971 and harbours the worldwide only C. Ph. E. Bach Museum. Many other historical persons like the Humboldt brothers, Konrad Wimpina, Friedrich Löffler even lived in Frankfurt. Today Henry Maske and Axel Schulz are part of the celebrities knowing to be Frankfurter.

VI. Only Black or is it Grey?

Many people reduce the German-Polish relationship to war or other conflicts during the millenniums. In their minds the Battle of Grunwald, the Second World War or the foray of the Mark of Brandenburg by Wladislaw I. show that there are only dark chapters in the German-Polish relation.
There are even positive sites. Economic integration is only one. But also many cultural connections show that there are not only shadows.
So a survey which were made by the MOZ shows that 68,7% likes to go shopping and 29,8% spend their free time in Słubice. A significant project which attracts even international attention is Słubfurt.
Michael Kurzwelly tries to show in that Project that Frankfurt and Słubice could be one town without a boarder in between. So he founded a Słubfurt youth club and a touristic information. That project mainly shows that German and Polish people have so much in common that if they would they could be more than only neighbours.

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Photovoltaic Energy Sources

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Abstract -This review takes note of one of the most environmentally friendly energy production technology that is photovoltaic systems, its types, elements and equipment.

I. INTRODUCTION

Nowadays the greenhouse gas emission from electricity generation is an important environmental problem on global scale. We can not stop produce electricity, but we can apply some alternative energy sources, which are less damaging to the environment. In this paper the photovoltaic idea will be described. It is commonly known, that the Sun has huge energy resources reaching every part of the Earth, and is available on all over the world area. Even less sunny surface of globe may use of sun energy to supply standalone devices, houses, or everyday use items. Solar radiation is a main energy source on Earth. The sun rays are use to produce heat and electricity. We have to realize, that solar energy is also use by the plants in photosynthesis effect. Energy of Fossil fuels also come from the sun, because many years ago the sun energy has been absorbed by biomass and next was evolved into coal, natural gas or crude oil by biochemical process. People have been using solar energy from a long time, firstly for drying food products and to start fire. Later people have started to use solar radiation for heat producing. In 1897 in Pasadena near Los Angeles almost 30% of houses was heating using solar energy. Nowadays the word largest producer of photovoltaic is Japan with 51,2% of worldwide production [3]. In comparison with other natural energy sources like wind or waterfalls, the Sun takes first place in energy potential with 89.7 TW, where the global consumption is about 15 TW [3]. Photovoltaic technology is one of the most environmentally friendly power producing technologies available today. “As its systems require no fuel and produce no emissions, this technology has the potential to play a major role in climate change mitigation and pollution reduction” [1]. The photovoltaic systems, its components are very simple to install, and maintain, can be easily used as a main or additional energy source. Next chapter let us know how does the photovoltaic cell work and introduce the typical components of photovoltaic installation.

II. PHOTOVOLTAIC SYSTEMS

Photovoltaic cell is a smallest component of system. Interconnected cells create modules, which are connected into arrays and so on. Connecting in this way any power can be obtained, without any constrains. Solar cells can be made from a wide range of semiconductor materials like silicon,

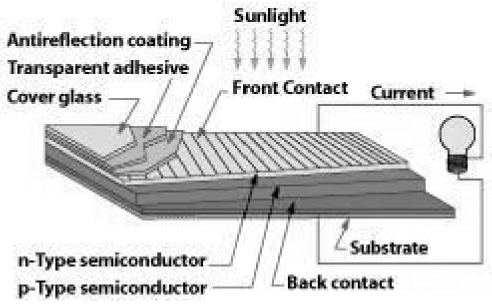

Figure 1. Sollar cell construction

polycrystalline, single crystalline. Most commond in use are silicon photovoltaic cells owing to low material cost, samll energy consumption during production procces of the solar modul, simplicity of embeded on flexible surfaces. Photovoltaic works using a photoelectric effect. Sunlight reaches the photovoltaic module and is absorbed. The surface of photovoltaic cell is covered by antireflective layer which increase absorption efficiency. Cell has two layers n and p and the junction between them. The cell has a negative and positive site similarly like battery (Fig. 1). The junction mentioned above takes from of permanent field and separates layers. Thanks of that, electrons can flow from the p – layer to the n – layer, it can not be inversely. Photons of sunlight are knocking an n – layer electron free, but they still stay in the same part of photovoltaic cell. The opposite situation occurs in n – layer, where knocked free electron can easily cross the junction to reach second layer, where the extra electrons are accumulated. Metal wire connected to the layer gives electrons way to go, so electrons moving through this wire enter the DC current. It means that electrons from the one layer go through the circuit and back to the second layer. Until the sun rays reach the photovoltaic cell the current will be flowing. Modules and arrays do not represent the PV without additional equipment as i.e. inverter which converts direct current to the alternative current. We can distinguish two types of photovoltaic system that is flat plate system and concentrator system. The main reason for using concentrator is to reduce quantity of photovoltaic cells, which are most expensive in whole system. The concentrators are made from relatively cheap material in comparison with cells, that is plastics lens or metal housing. The sunlight is captured by the concentrator surface and focused this energy onto smaller area where the photovoltaic cells are installed. It decrease the costs of the system. Solar systems are especially important in areas isolated from a public grid, like a highway where the emergency call phone boxes are supplied using photovoltaic, and also find application in water pumping, supplying traffic lights, cars, or small things like calculators, toys etc.

III. Other elements of photovoltaic system

The photovoltaic systems consist of not only photovoltaic cells but alsso other equipment like batteries, voltage controler or inverter which will be introduced in this charpter. The simplest way to storage energy produced by the photovoltaic cells is to use DC accumulator, especially that PV generate DC current needed to charge it. Charged battery can deliver electricity in cloudy days, when the solar radiation isn`t enough to produce electricity by PV. The Pb – acid batteries are commonly used. To maintain accumulators in good condition the high quality voltage controler should be apllied to extend the battery lifetime by limiting the speed and "depth" of accumulator discharge according to its temeperature. The voltage controler also limit speed of charging and the maximum charge level of battery what let us to avoid electrolyte evaporation. The range of charge and discharge voltage should be set suitably to battery type. The setting of voltage controller has big influence on battery lifetime so it should be done as well as possible. The next element of PV system is an inverter which changes alternating voltage into DC voltage, and gives shape to output voltage wave. Inverters are designed to operate all the time near the point of maximum power. The most important parameters of inverter are reliability and the characteristics of efficiency. In photovoltaic systems usually inverter is not fully loaded, and the high efficiency with small load is very important for inverters operating in central European climate, where annual average output power of photovoltaic panel is about 10% of rated power. In full load operation inverters have efficiency from 90% up to 96, and for 10% load from 85% to 95% [6].Inverter matching losses are bigger than resistance losses so the efficiency is decreasing according to the input/output power.

IV. Types of photovoltaic systems

We can distinguish three types of photovoltaic systems that are free - standing system, hybrid systems and grid connected systems. Free – standing system use only energy produced by photovoltaic cells and consist of PV module, accumulator and device which control the battery charge level. Accumulators should have enough energy to supply loads at night and in the case of bad weather. Hybrid systems have beside the PV consisted of additional power generator such as gas or wind generator. Those systems have more complicated control systems than free – standing. Because of using additional energy source the PV module can be smaller than in analogical free – standing system and thanks of that the hybrid system sometimes can be cheaper. Grid connected PV systems can take form of power plan with big quantity of PV modules sending the energy to power system. This kind of PV system can be applied to supply buildings, where energy from power system is deliver in the case of power demand exceed power produced by PV system. Those PV systems are connected to the grid through the inverter. Grid – connected systems do not need to use accumulators, because the powers system is able to get all energy produced by PV system.

V. Summary

Like every type of power generation method PV system has advantages and disadvantages. Using PV systems energy is produced directly, efficiency of conversion of electrical doesn`t depend on production scale. The next advantage is that the power is generated even on cloudy days. Maitenance and servis do not need to pay a lot of attention on it and finally the most important that during electricity generation there is no gas emmision to the atmosphere. In the near future PV systems will find application (g.e Poland) to supply consumers which are isolated from the power system. Taking into considerarion Poland, we can observe [Fig.2] that PV system can be apllied anywhere on the country area [7].

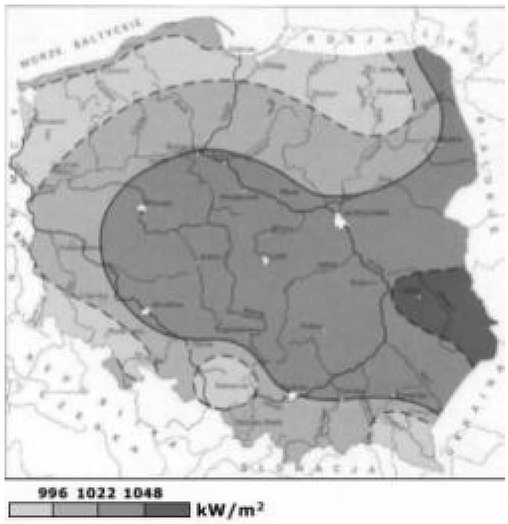

Figure 2. Inolation of Poland

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Intelligent Installations in Buildings

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Abstract-This paper concerns intelligent installations in buildings. LCN and KNX/EIB systems have been described.

I. INTRODUCTION

As we know very well our society is getting rich, therefore our requirements for comfort and functionality in houses are increase. Is it possible to rise these things from electrical point of view? The answer sounds: Yes, it is possible. But there is second question: How we can do that? The answer is only one. We can apply intelligent installations in our houses.

Thanks to intelligent installations we can control and manage all of systems or devices which exist in our houses. We don't have to remember about the light, which was left in the room or garage because it will be switched off by the system. Control of the lighting is the simplest example of capabilities of intelligent installations (intelligent buildings). New technologies provide that inmates are informed about all guests, both welcome and unwelcome. Control of whole house is very handy because we can check what is going on in any part of our house during having a rest or cooking. For example presence of somebody in bathroom can be signalized by signal lamp and open windows are indicated by blinking of signal lamp. Signal lamps can be replaced for example by display a text on liquid crystal displays.[1][3][5]

II. LOCAL CONTROL NETWORK

LCN (Local Control Network) is the system which was developed by Issendorff Microelectronic. LCN is designed to realization the following tasks: control of the lighting, control of the shutters and roller blinds. LCN can be responsible for monitoring of building and can control heating and air conditioning systems etc.[1]

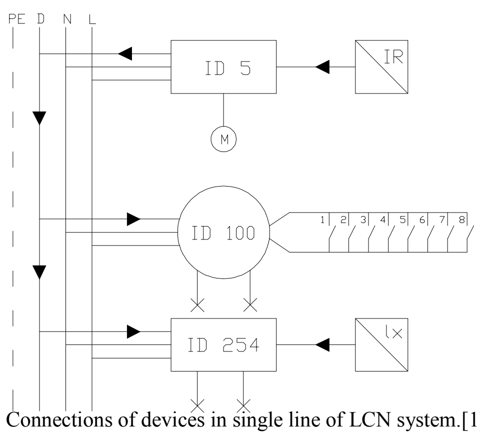

Figure 1. Connections of devices in single line of LCN system.[1][2][3]

LCN system can make use the standard electrical installation but we must put into use a special logical modules which can be installed in connecting box or in utility boxes behind the sockets, switches and pushes. All modules are connected by quadri-core or penta-core wire which consists of feeding conductor L, neutral conductor N, protective conductor PE and conductor for data transmission D. (Fig.1).[1] [3]

Modules of LCN system are main devices of LCN bus and they are communicate each other by neutral (N) and data (D) conductors. All of them contain the microprocessor, which can makes calculations, observes, communicates, operates and responds.[1] Modules work absolutely independently, they do not have to have additional power input or other feeders. Each modules consist of two outputs which supply the lighting and motors circuit (e.g. shutters, windows, gates etc.) These outputs have an opportunity to light dimming with individual setting of brightness level and rise time from 10 ms to 30 min. The maximum power of controlled receivers depends on type of module: 300, 500 or 2000VA. According to type of module it is equip with two or three ports which are inputs of sensors signals. Port T is adapted for cooperation with switching devices and a/c converter. Port I is adapted for cooperation with analog sensors e.g. temperature sensors, light intensity sensors, sensors to communication with pilot etc. The 3rd port P own modules which are placed in connecting box and this port can be treat as some kind of widening.[2][3]

As data vein we use normal vein, which is free in normal YDY cable. One segment can be consist of 250 modules at maximum (in big complex buildings we can connect up to 120 segments). By applying this kind of division we can distinguish different parts of the buildings e.g. floors in skyscraper or rooms in the house and also we can communicate between these segments for example to control the lights outside.(Fig.2)[2]

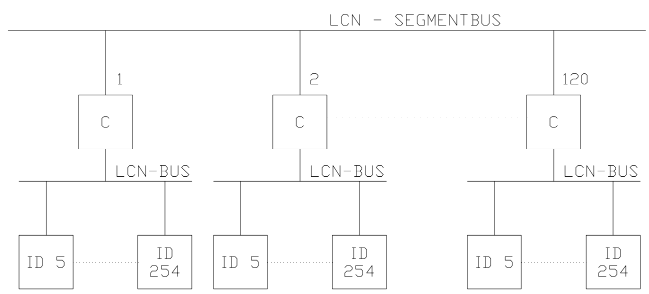

Figure 2. LCN system structure; C – couplings [1][2][3]

To make communication between LCN modules possible, every module must have its own address, which is programmed by LCN software (LCN-PRO or LCN-P) in several seconds. Address of module is a number between 5 and 254. If several segments of LCN are connected to main line, then segments must have numbers from 5 to 124. Form every place in the network we can send telegrams to address. If the packet of information must be send to more users, then it is about group address. Every segment might have up to 250 groups from number 5 to 254. The number of modules in the group is not limited and every module can belong to 12 groups. Groups in LCN are actually formed when several modules should be controlled simultaneously. [2]

III. KNX/EIB

KNX/EIB system was designed to control of installation in buildings. The KNX/EIB system is the worlds only open standard home and building control system. This means we are not limited to products from one manufacturer for their system alone. We can choose products from hundreds of different manufactures and they will communicate with each other. Using this system we can control, signal, regulate and supervise all kind of devices in our home. With KNX, we can truly feel safe. When we are leaving the house and would like to know, for example, whether all the windows are closed and if all the lights are off, a central display unit next to the front door will tell us everything at a glance. When we are away, the system will simulate our presence by automatically controlling lights and blinds in accordance with our everyday routine. This system replaces the standard electrical installation which can not achieve requirements of users.[1][3]

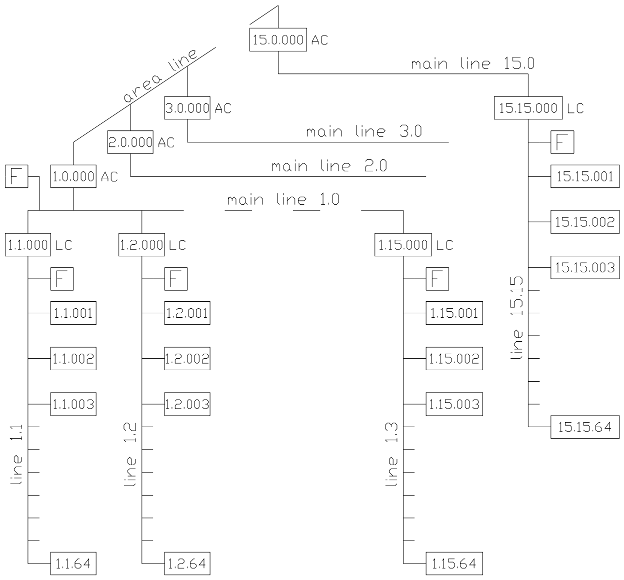

Figure 3. Topology of KNX/EIB system; F – feeder, LC – line coupling, AC – area coupling [1] [3]

In EIB system traditional switches which connect or disconnect feeding or sensors and other control elements were replaced by digital devices which communicate each other using one conductor (bus). This conductor is supply by ±24V in SELV system and runs round a building and connects all bus devices of the system. Devices in KNX\EIB system can be divided in: bus devices, this means devices which generate commands and control receivers; system devices which assure of correct working of main devices. Among the bus devices we can distinguish sensors and actuators. Sensors are devices which generate signals based on measured physical quantity and the actuators are execute elements, this means that actuators carry out orders which are transmit by bus. The actuators are steering of specified receiver or group of receivers. For system devices are include: feeders, couplings and interface. The feeders are responsible for supply the bus, that is all its particular lines. Each line is supply by one feeder at least. Couplings are use for galvanic separation between lines and for filtration of telegrams which are address only to devices that are limited by given coupling. Interface is used for communication between devices and computer.[3]

Fundamental element of KNX/EIB system is line, which can group up to 64 bus devices. Each line must have at least one feeder. Expansion of the bus consist in creating new lines. These lines are connected by main line but all lines are separated by line coupling. In KNX/EIB standard one main line can connect up to 15 lines and this creates area. We can connect up to 15 areas by area line, which connects main lines using area couplings. Couplings are fed by line from lower level, this means line couplings are fed by feeder from its own line, area couplings are fed by main line feeder so area lines have not to have a feeder.[3]

Each element of KNX/EIB system has its own, unique ID number and it is called physical address. How the filtration of telegrams works?? It is very easy. For example, the telegrams are sent from line 1.5 and they are addressed to devices of this line, so these telegrams are not pass by coupling 1.5.000 to the main line 1.0 and to the others bus lines of course. But if any telegram is addressed to device from line 1.1, it is pass through the coupling 1.1.000 to the main line 1.0 and to the line 1.1. Aim of the filtration of telegrams is restriction of transmit data time.[3]

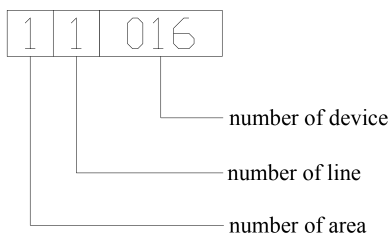

Figure 4. Physical address in KNX/EIB system [3]

IV. SUMMARY

Different kind of installations within intelligent homes and building are more and more popular and commercially available, therefore they can be applied not only in industrial or sport complexes, but in our houses too. Thanks to intelligent installations our houses are more comfortable, more functional and safer. We can control our house not only by control desk or pilot, LCN and KNX/EIB systems make possible to control them using internet or mobile. This means we can check what is the temperature in our home during holidays, or we can verify if all windows have been closed by sending one SMS.

TABLE I
ADVANTAGES OF INTELLIGENT INSTALLATIONS [6]

Security	- alarms - fire protection - access control - closing system - visualization - roller blind control
Energy - saving	- heating control - ventilation control - sun, rain, wind and light sensors - control of room one by one
Comfort	- control of lighting with memory - wireless control - simulation of presence at home - control by internet and mobile

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Author Index

A

B

C

D

E

F

G

H

I

J

K

L

M

T

U

V

W

X

Y

Z